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WATER RESOURCES ACTIVITIES IN THE UNITED STATES. FUTURE NEEDS FOR RECLAMATION IN THE WESTERN STATES

Select Committee on National Water Resources, U. S. Senate

April 1960

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WATER RESOURCES ACTIVITIES IN THE UNITED STATES

FUTURE NEEDS FOR RECLAMATION IN THE WESTERN STATES

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SELECT COMMITTEE ON NATIONAL WATER RESOURCES
UNITED STATES SENATE

PURSUANT TO

S. Res. 48

EIGHTY-SIXTH CONGRESS

APRIL 1960

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STATEMENT BY THE CHAIRMAN

APRIL 27, 1960.

To the Members of the Select Committee on National Water Resources:

As one of the studies under Senate Resolution 48, by the Select Committee on National Water Resources, I asked the Department of the Interior to prepare a report for the committee on the needs for future irrigation and reclamation development in the 17 Western States. The Western States have had a more rapid growth in population and economic activity in recent years than the country as a whole. One of the important factors involved in that growth has been the development of the water resources, an important stimulant of which has been the Federal reclamation program.

Since the inception of that program in 1902, through 1959, over $4 billion has been appropriated for reclamation projects and activities in the 17 Western States. Almost 7 million of the 30.5 million irrigated acres in the West are served by Federal reclamation projects. In addition, the program has yielded substantial benefits in the form of municipal and industrial water supplies, low-cost hydroelectric power, water recreational facilities, and improved fish and wildlife habitat. In view of the competence developed by the Bureau of Reclamation in planning and executing this tremendous program, I asked the Secretary of the Interior to have the Bureau report to us on the anticipated future development of reclamation in the West between now and the year 2000, including Federal, State, and local projects.

In preparing the report, the Bureau of Reclamation has inventoried over 1,000 potential projects which might be suitable to help meet those needs, of which 650 were classified as potential Federal projects. The Bureau believes that the increasing needs for food and fiber and for new economic opportunities will require the greatest practical acreage of land in the West that can be reasonably and economically irrigated. The Bureau indicates that development of the full physical irrigation potential of the West will never be realized because of factors such as excessive cost, competition by other uses for the limited supply of water, lack of local interest, and legal and other limitations on what we can do with water which will always preclude some potential development. With these limitations, however, the Bureau believes that about 75 percent of the potential Federal projects and 90 percent of the non-Federal projects could be developed by the year 2000.

Such a program would provide for the irrigation of the equivalent of 17 million acres of new irrigated land, at a cost of $22 billion. The Bureau considers it reasonable to expect that about 9.5 million acres might be developed federally, and 2.7 million by non-Federal interests, exclusive of the California State water plan, which would add 4.8 million acres that it is considered would justify some Federal contribution to the State's efforts. Estimated total project costs at 1959 price levels would be $12 billion for the Federal projects, $1.4 billion for the non-Federal, and $8.6 billion for the California State water plan.

The Bureau of Reclamation points out that full efficient utilization of the water resources of the West would require significant changes in existing patterns of water use. Many involved water exchanges would have to be worked out. The State water laws with respect to ground water would need perfecting. Provisions for supplying financial assistance to irrigation development would need to be expanded. Uncertainties with respect to effects of watershed programs on streamflows would need to be resolved through research and cooperative action. Clarification of Federal policy on various aspects of water resource development such as interest rates, standards of economic analysis, and recreational and fish and wildlife developments, would be needed, as well as improved means for providing for cooperation between the Federal Government and State and local interests. If these problems can be solved the Bureau of Reclamation believes additional reclamation in the West could provide food and fiber for 25 million people through the development of 230,000 additional family-size farms, which

could support an onfarm population of 800,000, and a local nonfarm population of 2.4 million. This would support over 40,000 local retail enterprises doing $4 billion in retail trade annually, and would increase Federal revenue collection by about $900 million annually. Other important benefits not susceptible of being expressed in monetary terms would be realized.

The report by the Bureau of Reclamation makes a valuable addition to the committee's studies and will be of interest to all of you. Accordingly, I am having it printed as one of our series of committee prints covering all aspects of water resources activities in the United States, so that the information it contains will be available to the members of the committee, to other Members of the Senate, and to all who are interested in water resource development in the Western States.

ROB'T S. KERR,
Chairman, Select Committee
on National Water Resources.

COMMUNICATIONS

JULY 1, 1959.

Hon. FRED A. SEATON,
Secretary of the Interior, Department of the Interior, Washington, D.C.
(Attention: Floyd E. Dominy, Commissioner Bureau of Reclamation).

MY DEAR MR. SECRETARY: Further reference is made to my letter of June 15, 1959, concerning the work of the Select Committee on National Water Resources.

One of the fields in which the committee will need information is reclamation in the Western States. The committee has great confidence in the work of the Bureau of Reclamation and considers that the Bureau is well equipped to discuss and comment on all aspects of this field. Accordingly, it is requested that a report on potential reclamation in the West be prepared for us by the Bureau of Reclamation.

Principal objective of the report is to inform the committee on needs for future irrigation and reclamation development in the 17 Western States and to provide the committee with estimates of costs and probable water requirements for anticipated future developments between now and 1980, and looking ahead to the year 2000 (or 2010).

The report should include a brief summary of existing development of the West and should cover needs for future water resources development in relation to other resources of the West and in relation to stated assumptions as to population and economic activity of the Nation. We would like consideration to be given to all of the economic and social objectives of national resources development policies with the Bureau's best appraisal of the needs for development to help meet these objectives. Discussion should be included as to how needs might be met under the present reclamation law and what changes in the law might help in meeting future needs. Potential projects should be discussed in terms of probable costs and benefits and water requirements, giving limitations of estimates. Consideration should be given to Federal (including Indian) and non-Federal developments.

In addition the committee would like to have some discussion of the problems of coordination of reclamation development with other aspects of water resources development and any other comments which the Bureau of Reclamation would like to make relative to future water resources development problems.

We would like this subject to be covered in a summary report of not more than 10,000 words with whatever tables, charts, appendixes, and graphic illustrations as may be considered necessary. It would be most helpful if this information could be furnished the committee by October 1, 1959.

The committee staff will be glad to discuss any problems which may arise in the preparation of the report with representatives of the Bureau of Reclamation.

Sincerely yours,

ROB'T S. KERR, *Chairman.*

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D.C., April 20, 1960.

Hon. ROBERT S. KERR,
Chairman, Select Committee on National Water Resources,
U.S. Senate, Washington, D.C.

DEAR SENATOR KERR: In response to your letter of July 1, 1959, we present, herewith, our report on "Reclamation in the West, Present and Future, and Its Effect on Water Supplies." Enclosed also as a supplement to the report is the information on total appropriations for the reclamation program by States and by decades through June 30, 1959, as requested by your letter of December 2, 1959.

The enclosed report was prepared by the Bureau of Reclamation from data assembled not only from its own files but from many other Federal, State, and local agency sources. The contributions that have made this report possible are gratefully acknowledged.

The report is oriented to the principal objectives of informing the select committee on needs for future irrigation and reclamation development in the 17 reclamation States and of providing the committee with estimates of costs and probable water requirements for anticipated future developments through the year 2000. The report is based largely on an analysis of more than 1,000 known potential projects, and is, we believe, the most comprehensive look ahead for irrigation in the West yet attempted. The projected future programs which reflect anticipated irrigation developments are considered those that reasonably and economically could be accomplished but without regard to budgetary considerations that would be involved. In evaluating undeveloped potentials and in projecting future programs, judgment necessarily was used in many instances where firm data were not available.

Viewed in this context and recognizing the limitations in any long-range projection, we believe the report will be useful in evaluating the future of irrigation in the West, the form and direction it will take, its economic impact, and its effect on water resources.

Should you desire, we will be glad to discuss and explain further the basis upon which the report was prepared.

Sincerely yours,

FRED A. SEATON, *Secretary of the Interior.*

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FOREWORD

There is a growing awareness nationally, and even worldwide, of the importance of water in our lives and of the need for its proper conservation and use. The Bureau of Reclamation of the Department of the Interior, in nearly six decades of operation in the Western States, has evolved a multipurpose concept of water use which fulfills needs not only for irrigation water but for municipal and industrial use, hydropower generation, navigation, recreation, fish and wildlife enhancement, and flood, salinity and pollution control.

However, this report, prepared at the request of the Senate Select Committee on Water Resources, is concerned primarily with the needs and potentials for expansion of irrigation in the 17 reclamation States and the means or programs by which future requirements can be met. The report necessarily is limited to the broad aspects of the problems involved and cannot be considered as specific in detail. Its basic value lies in its evaluation, on a scale and basis never before attempted, of the potentialities and projected future possible accomplishments in the field of irrigation expansion.

The report reviews briefly from a historic standpoint the role and importance of irrigation in the development of the West and summarizes the status of existing irrigation improvements, both Federal and non-Federal. It discusses the need for future irrigation development and outlines the remaining undeveloped potentials. It projects a program to meet future requirements to the year 2000 and estimates the accomplishments that may be expected from such a program. It discusses briefly future problems that can be foreseen now that will require special attention.

In determining undeveloped potentials and in projecting a future program, more than 1,000 prospective projects were examined and evaluated to the extent that existing data and information permitted. While reasonably firm information was available for many projects, it was necessary that varying degrees of judgment be used in evaluating others from existing data.

In preparing this report the Bureau of Reclamation worked primarily through seven regional offices, divided according to western drainage basins, which assembled basic information on the existing and prospective programs. The exercise of judgment by seven different regional offices in the assembly and analysis of vast amounts of data in a short period has inevitably resulted in some differences in the interpretation and derivation of statistics and projections. However, in the broad overall picture presented herein, such discrepancies are not believed to be of significance. The preparation of the report required the reassembling of the basic information on irrigation on the basis of specific water resource regions as defined by the select committee in contrast to the State or drainage areas which are customarily used in reporting such data. The 17 reclamation States include 9 of these regions and portions of 2 others.

After the data were assembled and totaled, it was observed that the irrigated acreages thus reported for the 17 reclamation States were somewhat less than those reported in some sources but agreed closely with reported acreages in the 1954 U.S. Census of Agriculture. Therefore, the materials presented in this report are based directly upon the materials provided primarily by the seven regional offices. In addition, the Bureau of Indian Affairs provided information on the prospective program under its jurisdiction.

In the course of the assembly of the basic data reported herein, representatives of the regional offices contacted many State, local, and Federal representatives. It would have been impossible to have prepared this report without the assistance of such individuals. Their contribution is gratefully acknowledged.

Although many individuals and agencies contributed in one manner or another, the Bureau of Reclamation is responsible for the assembly of the information, the preparation of the report, and the basic conclusions reached herein.

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FUTURE NEEDS FOR RECLAMATION IN THE WESTERN STATES

Chapter I. The Role of Irrigation in the Development of the West

Irrigation in the United States has been practiced for many centuries. The canal-building Hohokam Indians of the Southwest had developed an advanced culture by the year 1400 A.D. Some of the large irrigation works in use for irrigation of the Salt River Valley in Arizona follow the alinement of these old canals.

Spanish explorers and colonizers in the Southwest brought from Europe a knowledge of irrigation based on Arabic experience and established simple irrigation facilities by the year 1600. For the ensuing two and a quarter centuries the only significant permanent agriculture in the arid West by the white man was that surrounding the Spanish missions and settlements.

In 1847 the Mormon settlers of Utah established the first successful modern irrigation farming operation. By 1850 they had placed 16,000 acres under irrigation, and by 1890 their irrigated area had grown to 263,500 acres. Their cooperative principles of irrigation worked out through the experience of trial and error are basic to present processes governing irrigation in the West.

Other pioneer settlements based on use of nearby streams gradually followed. In northern Colorado, the Union colony was established in the early 1870's near what is now the city of Greeley. At the same time the Riverside and Anaheim colonies were being established in southern California. With the decline of fur trading and placer mining, the trappers and miners found it necessary to enter other activity. Some of them took up ranching in the mountain areas, but they soon found that irrigation was necessary to insure a winter feed supply for their livestock herds. In addition, there was a constant flow of westward-bound settlers. Thus, starting about 1870, irrigation expansion began at a relatively constant rate.

The centers of population at the Indian irrigated areas, Spanish settlements, Mormon villages, and scattered ranches were the way stations of the West during the early days. Today, these old crossroads are the major towns and cities of that area.

By 1900 the Western States had slightly over 7 million acres under irrigation. By 1950 the irrigated area had reached 25 million acres, and by 1958 it comprised about 30.5 million acres. Between 1950 and 1958, the irrigated acreage in the 17 reclamation States increased about 22 percent.

This rapid growth contrasts sharply with the sparse settlement, laborious transportation, and dormant resources of the vast public domain when the West was still young. It reflects a national policy to incorporate the West into the national economy on a sound basis offering new opportunity for national growth and welfare. Federal sponsorship of major irrigation works is one of the most important instruments by which this policy has been implemented.

The first irrigation developments depended entirely on the simple diversion of natural streamflow. As development proceeded it became evident that further expansion depended upon the provision of an additional source of water or on more elaborate means of transporting existing riverflows to irrigable land. The construction of storage and/or large-scale pumping plants, which comprised the obvious solution, was relatively expensive and beyond the means of most groups of water users. In response to this need the Federal Government entered the irrigation field and has been responsible for the construction of substantial storage and pumping facilities. These, in turn, have provided the basis for the continued expansion of irrigation.

Federal assistance in irrigation took several forms, including the Desert Land Acts of 1877 and 1891. The first act of major significance was the Carey Act of 1894 which was designed to encourage irrigation development on public land and provided for land grants to the States for

resale to individuals. More than a million acres of land were reclaimed under the provisions of this act.

Difficulties arose, however, from the limited financial resources of States and individual promoters and from the absence of sufficient safeguards against inadequate engineering and hydrologic studies. In a number of instances, poorly formulated or speculative ventures had resulted in a breakdown of public confidence in large-scale irrigation proposals and resulted in a recognition of the need for responsible sponsorship of investigations, construction, and settlement practices. The Reclamation Act of 1902 overcame many of these shortcomings, and it has since provided an important basis for the continued development and economic growth of the 17 reclamation States. In addition to providing many facilities by Federal financing and construction on a reimbursable basis, it has established the technical pattern and know-how that has permitted expansion of private development. Today about one-fifth of all irrigated lands in the West receive a full or partial water supply from facilities constructed by the Bureau of Reclamation.

Irrigation is important from several points of view. It originally provided the means for making many areas of the Western States suitable for settlement. It provided a frontier in which people could find opportunity for profitable self-employment in periods of economic adversity. It provided a means for the development of many areas and the attendant benefits such as highways, railroads, schools, and community integration that goes with such development. It provided a winter feed base which is necessary for the utilization of the adjacent rangelands to which the Nation looks for a significant part of its meat supply.

Irrigated agriculture is characterized by a diversity of crop production and flexibility. This flexibility and wide adaptability is important in that it enables shifts in production to meet changing requirements and demands. In recent years there has been an increase in emphasis on the protein and protective foods. In response to this requirement there have been significant shifts in the types of crops produced on irrigated farms. More and more emphasis is placed on the production of livestock products and fruits and vegetables.

The irrigated acreage in the 17 reclamation States amounts to less than 10 percent of the total cropland in the United States. However, because of the high yields secured on irrigated lands, the small percentage of irrigated lands that is idle, and the fact that it is not necessary to summer-fallow irrigated lands in the manner practiced in extensive subhumid areas, 1 acre of irrigated cropland will produce, on a national average, the equivalent of 3 acres of nonirrigated cropland. As noted, however, the emphasis is on livestock products and fruits and vegetables. Irrigation often results in switching lands from production of crops in surplus supply to production of crops in demand.

The population of the 17 reclamation States roughly doubled each decade between 1850 and 1900 and increased by 25 percent each decade from 1900 to 1950. Between 1940 and 1950 the population of the United States grew 14½ percent and that of the 17 reclamation States increased 29 percent. In the same period, seven widely separated counties dependent on irrigation in Arizona, California, Idaho, Nebraska, Texas, and Washington grew at the rate of 46 percent.

There are countless examples throughout the West of the capacity of irrigated communities to continue this growth after the surrounding dryland reaches its full population potential. The Strawberry Valley project in central Utah, for instance, has been the basis for a sustained population growth each decade since 1860 with no leveling of the growth curve. Adjacent dryland counties, however, while showing the same early growth, approached the limits of settlement of rangelands about 1915. Since that time the population of these adjacent counties has declined at the rate of 10 percent each decade.

Economic development accompanying the growth of irrigation projects proceeds in three distinct stages of economic activity. During the period of construction, local employment is high, retail sales boom, and there is an active market for real property. Communications and imports increase sharply. Wholesale trade, plant expansion, manufacturing, and transportation are stimulated in the surrounding region, and large orders are placed with heavy industry throughout the Nation.

During the developmental stage after water becomes available, the construction workers are succeeded by permanent settlers. A period of light construction follows, fulfilling the need for

new homes, churches, schools, stores, land leveling, and roadbuilding. Regional and national sources provide farm implements and household appliances. Trade accelerates as agricultural commodities are shipped out and more consumer goods are moved in.

In the operating stage, a steadier and somewhat slower growth pattern is established. Facilities for processing and shipment of agricultural commodities are provided, and the sustained growth strengthens and supports the local, regional, and national economy. New homes, new employment, new outlets for investment capital, an increased volume of agricultural products, and increased profits to suppliers of goods and services are tangible evidence of the economic significance of irrigation in areas where water supplies are available.

Chapter II. Summary of Existing Development

In 1958 there were about 34 million acres of irrigated land in the United States, of which some 30.5 million acres were in the 17 reclamation States. Twenty-one percent of the farms in the reclamation West are partially or wholly irrigated. As shown on map 1, the acreage is distributed among the water resource regions in the following manner:

Pacific Northwest	4, 600, 000
Central Pacific	7, 100, 000
South Pacific	800, 000
Great Basin	1, 950, 000
Colorado River	2, 900, 000
Upper Missouri River	6, 800, 000
Lower Missouri River (in Kansas)	[1]
Upper Rio Grande River	1, 650, 000
Upper Arkansas-Red Rivers	1, 600, 000
Lower Arkansas-Red-White Rivers (in Kansas, Oklahoma, and Texas)	[1]
Western Gulf	3, 100, 000
Total	30, 500, 000

[1] Minor.

Land use reported for the river basins of the 17 reclamation States in terms of the acreage and production of various crops is shown in table 1. Present irrigated farming ranges from extensive use for hay and pasture to very intensive use for citrus fruits, dates, avocados, and many kind of vegetables. Double cropping is practiced in the Southwest, largely in the production of vegetables. A wide range of row crops is grown, including sugar beets, potatoes, beans, and cotton.

Irrigated farms provide feed for farm livestock and a feed base for sheep and cattle which are pastured during the summer on range and forest land. There are about 10 million cattle and calves and 6.5 million sheep on irrigated farms at the beginning of each year. About one-third of these animals are raised entirely on irrigated farms, and the remainder are pastured on range and forest land. It is estimated that some 200 million acres of rangeland are associated with irrigated land in this manner.

Table 1.—*Crops grown under present irrigation (Federal and non-Federal), 17 reclamation States*

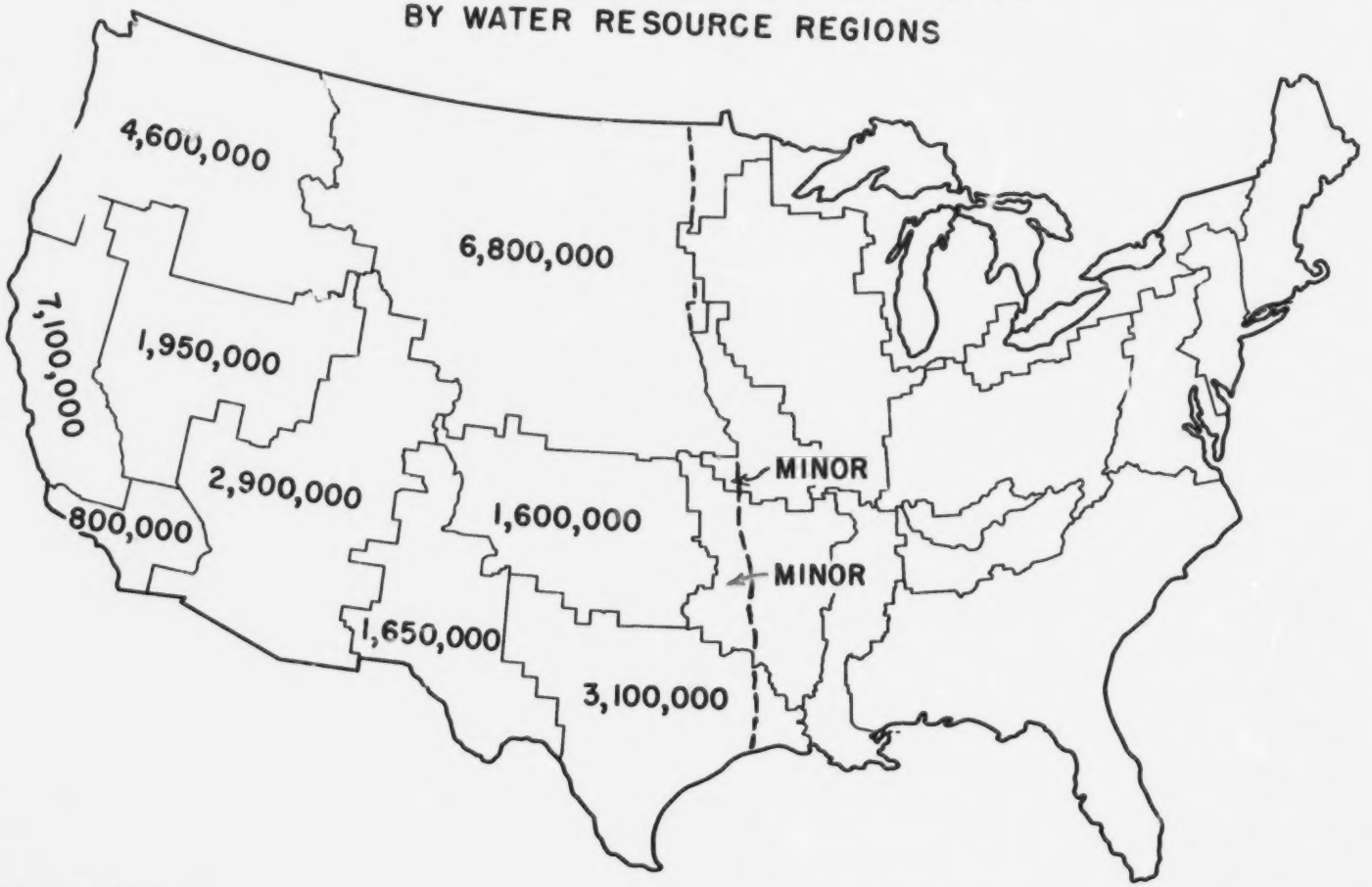
Item	Acres		Units	Production	Average yield per acre [1]
	Number	Percent			
Corn	2, 282, 000	7.5	Bushels	157, 642, 000	69
Oats	620, 000	2.0	do	29, 304, 000	47
Barley	1, 775, 000	5.8	do	80, 725, 000	45
Grain sorghums	2, 300, 000	7.5	do	123, 140, 000	54
Mixed grain	6, 000		do	205, 000	34
Forage	375, 000	1.2	Tons	5, 598, 000	15
Hay	11, 400, 000	37.5	do	30, 111, 000	2.6
Pasture	460, 000	1.5	AUM	3, 143, 000	6.8
Wheat	1, 615, 000	5.3	Bushels	58, 028, 000	36
Rye	20, 000	1	do	373, 000	19
Rice	820, 000	2.7	Hundredweight	28, 283, 000	34
Potatoes	710, 000	2.3	do	123, 950, 000	175
Sugar beets	675, 000	2.2	Tons	10, 959, 000	16.2
Sweetpotatoes	16, 000	.1	Hundredweight	1, 352, 000	85
Dry beans	820, 000	2.7	Pounds	1, 331, 107, 000	1, 623
Soybeans	16, 000	.1	Bushels	273, 000	17
Cotton	2, 875, 000	9.4	Bales	4, 849, 000	1.69
Flaxseed	40, 000	.1	Bushels	1, 233, 000	31
Peanuts	50, 000	.2	do	2, 123, 000	42
Fruit	1, 930, 000	6.3	Dollars	1, 080, 800, 000	560
Vegetable	1, 350, 000	4.4	do	459, 000, 000	340
Other	345, 000	1.1	do	48, 300, 000	140
Total	30, 500, 000	100.0			

[1] Yield calculated on basis of acreage and production.

In areas like the Great Plains which are subject to recurrent drought, farm operators have found that irrigation takes much of the risk out of livestock production. A small irrigated acreage on each farm will provide a dependable feed supply and will permit the addition of livestock production as a complement to grain farming.

Irrigated lands together with associated range pasture contribute over 3 billion pounds of beef and veal and 500 million pounds of lamb and mutton annually to the national diet. This averages about 20 pounds of meat per person in the United States. The irrigated areas also contribute substantially to the production of dairy and poultry products.

IRRIGATED ACREAGE
IN THE SEVENTEEN RECLAMATION STATES
BY WATER RESOURCE REGIONS



TOTAL REPORTED ACREAGE.....30,500,000 ACRES

MAP I

Table 2 and chart 1 show the growth of irrigated acreage reported for the 17 reclamation States since 1900. This growth is the result of the combined efforts of individuals, local groups, States, and Federal agencies. The rate of development slowed during the first three decades of this century but has increased since the 1930's, showing the greatest acceleration in the last 10 years.

TABLE 2.—*Irrigation development in the 17 reclamation States*

[In acres]

Decade	Non-Federal	Federal	Total	Cumulative totals
Prior to 1900	6,700,000	450,000	7,150,000	7,150,000
1900 to 1909	3,650,000	850,000	4,500,000	11,650,000
1910 to 1919	2,800,000	1,000,000	3,800,000	15,450,000
1920 to 1929	950,000	500,000	1,450,000	16,900,000
1930 to 1939	900,000	600,000	1,500,000	18,400,000
1940 to 1949	3,000,000	1,450,000	4,450,000	22,850,000
1950 to 1958	5,950,000	1,700,000	7,650,000	30,500,000
Total	23,950,000	[1] 6,550,000	30,500,000	30,500,000

[1] Does not include all acres for which a supplemental supply was furnished as an assignment between Federal and non-Federal was made for such lands. In 1958 some 6,750,000 acres of land received either a full or supplemental water supply from the Bureau of Reclamation program, about 575,000 acres received water from Bureau of Indian Affairs developments, and a minor amount of acreage received water from other Federal sources.

Non-Federal development of water supply is responsible for four-fifths of the presently irrigated acreage. Of the remaining one-fifth furnished water in whole or in part from federally developed facilities, about one-half is in lands initially developed under private enterprise. The early developments consisted of simple diversion structures and canals, but the possibilities for this type of irrigation were soon limited by the amount of easily divertible natural riverflow available during the irrigation season. Irrigation from storage and from more elaborate pumping installations was then undertaken, followed in recent years by the rapid development of ground water. The Federal Government has been primarily active, especially in recent years, in supplying storage and pumping facilities, while non-Federal interests have concentrated their efforts on irrigation from easily divertible natural flow and ground water. From 1919 to 1949 the non-Federal development dependent upon natural flow overran the water supply and declined in acreage, thus stimulating the construction of storage. The recent increase in non-Federal storage is primarily due to the growing interest of various States in this type of development. These various trends are shown in table 3 and chart 2.

TABLE 3.—*Irrigation development [1] by source of water and decades, 17 reclamation States*

[In acres]

Items	Natural flow	Storage	Ground water	Total
Federal:				
Prior to 1900	443,000			443,000
1900 to 1909	714,000	149,000		863,000
1910 to 1919	186,000	785,000	8,000	979,000
1920 to 1929	30,000	396,000	63,000	489,000
1930 to 1939	61,000	534,000	6,000	601,000
1940 to 1949	508,000	946,000	3,000	1,457,000
1950 to 1958	117,000	1,497,000	81,000	1,695,000
Total	2,059,000	4,307,000	161,000	6,527,000
Non-Federal:				
Prior to 1900	5,853,000	218,000	70,000	6,141,000
1900 to 1909	2,631,000	311,000	338,000	3,280,000
1910 to 1919	879,000	548,000	881,000	2,308,000
1920 to 1929	−227,000	454,000	646,000	873,000
1930 to 1939	−70,000	324,000	607,000	861,000
1940 to 1949	−32,000	263,000	2,883,000	3,114,000
1950 to 1958	112,000	649,000	5,135,000	5,896,000
Total	9,146,000	2,767,000	10,560,000	22,473,000
Total, Federal and non-Federal:				
Prior to 1900	6,296,000	218,000	70,000	6,584,000
1900 to 1909	3,345,000	460,000	338,000	4,143,000
1910 to 1919	1,065,000	1,333,000	889,000	3,287,000
1920 to 1929	−197,000	850,000	709,000	1,362,000
1930 to 1939	−9,000	858,000	613,000	1,462,000
1940 to 1949	476,000	1,209,000	2,886,000	4,571,000
1950 to 1958	229,000	2,146,000	5,216,000	7,591,000
Total	11,205,000	7,074,000	10,721,000	29,000,000

[1] This table does not add to total irrigations as complete data were not available.

Reservoir storage normally is used to firm natural flows, and on a normal project the irrigation water supply is an admixture of natural flows and stored water. On a pro rata basis, about 7 million acres of land are now irrigated from storage. Table 4 shows that there are about 190 million acre-feet of capacity in reservoirs used wholly or in part for irrigation in the 17 reclamation States, of which over 107 million acre-feet are usable for irrigation. In addition to serving

TABLE 4.—*Existing storage related to irrigation, 17 reclamation States*

[In acre-feet]

Item	Amount [1]
Federal storage, total	169,415,000
Irrigation	90,689,000
Power	100,234,000
Flood control	38,401,000
Other	15,956,000
Non-Federal storage, total	20,261,000
Irrigation	16,385,000
Power	5,042,000
Flood control	173,000
Other	294,000
Federal and non-Federal storage, total	189,676,000
Irrigation	107,074,000
Power	105,276,000
Flood control	38,574,000
Other	16,250,000

[1] Amount reported by functions includes joint use space.

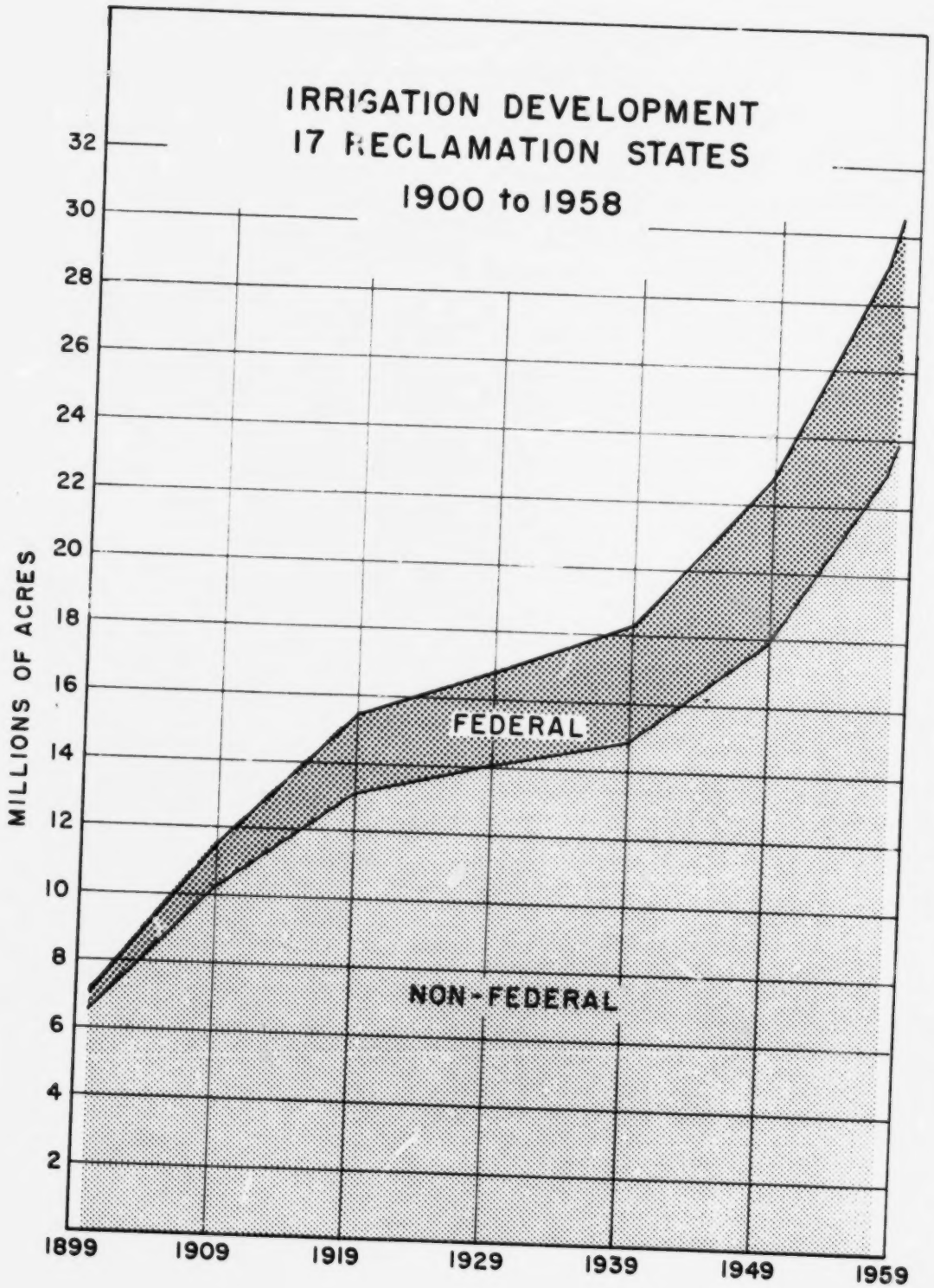

IRRIGATION DEVELOPMENT
17 RECLAMATION STATES
1900 to 1958
MILLIONS OF ACRES
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
FEDERAL
NON-FEDERAL
1899
1909
1919
1929
1939
1949
1959

Chart 1

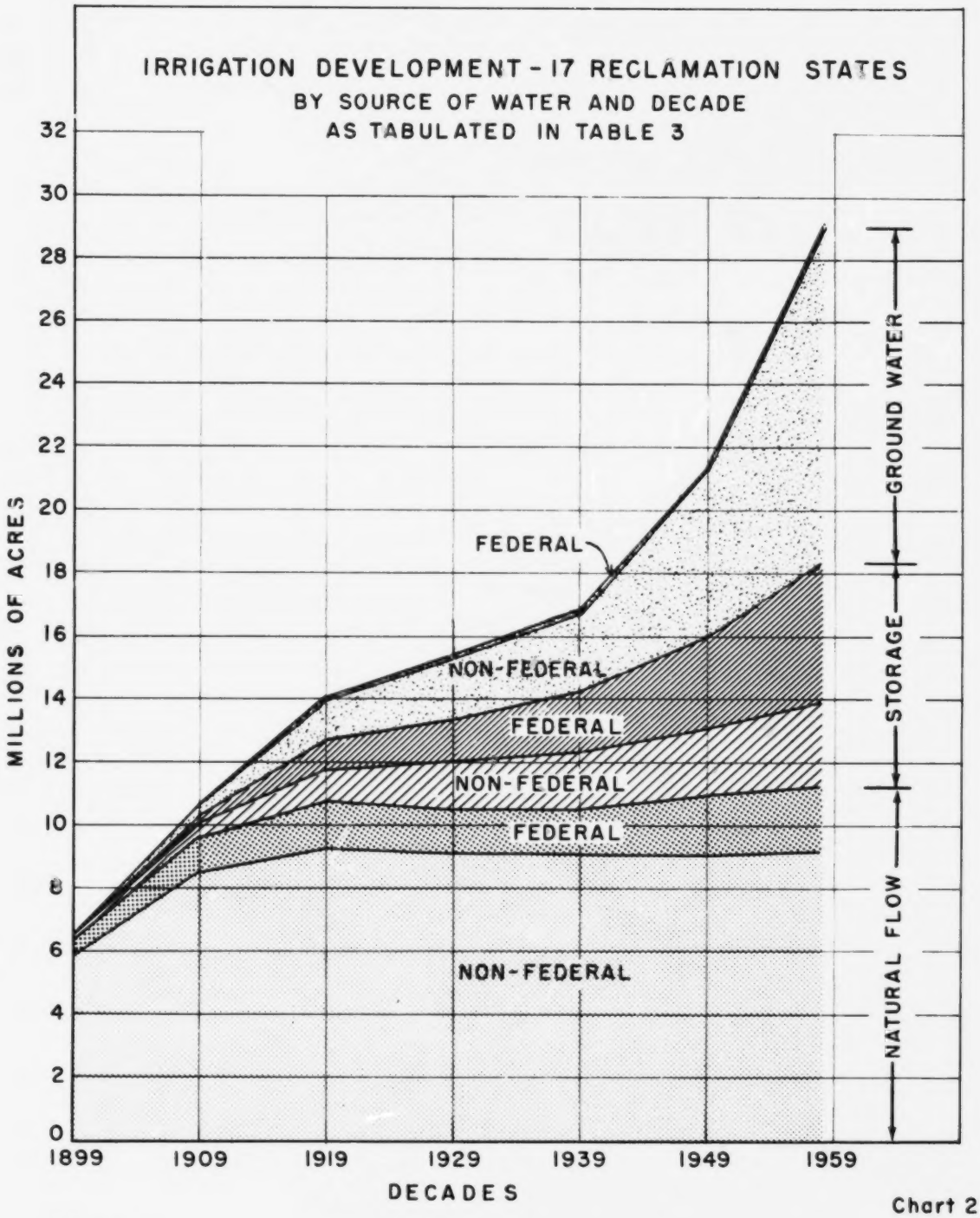


Chart 2

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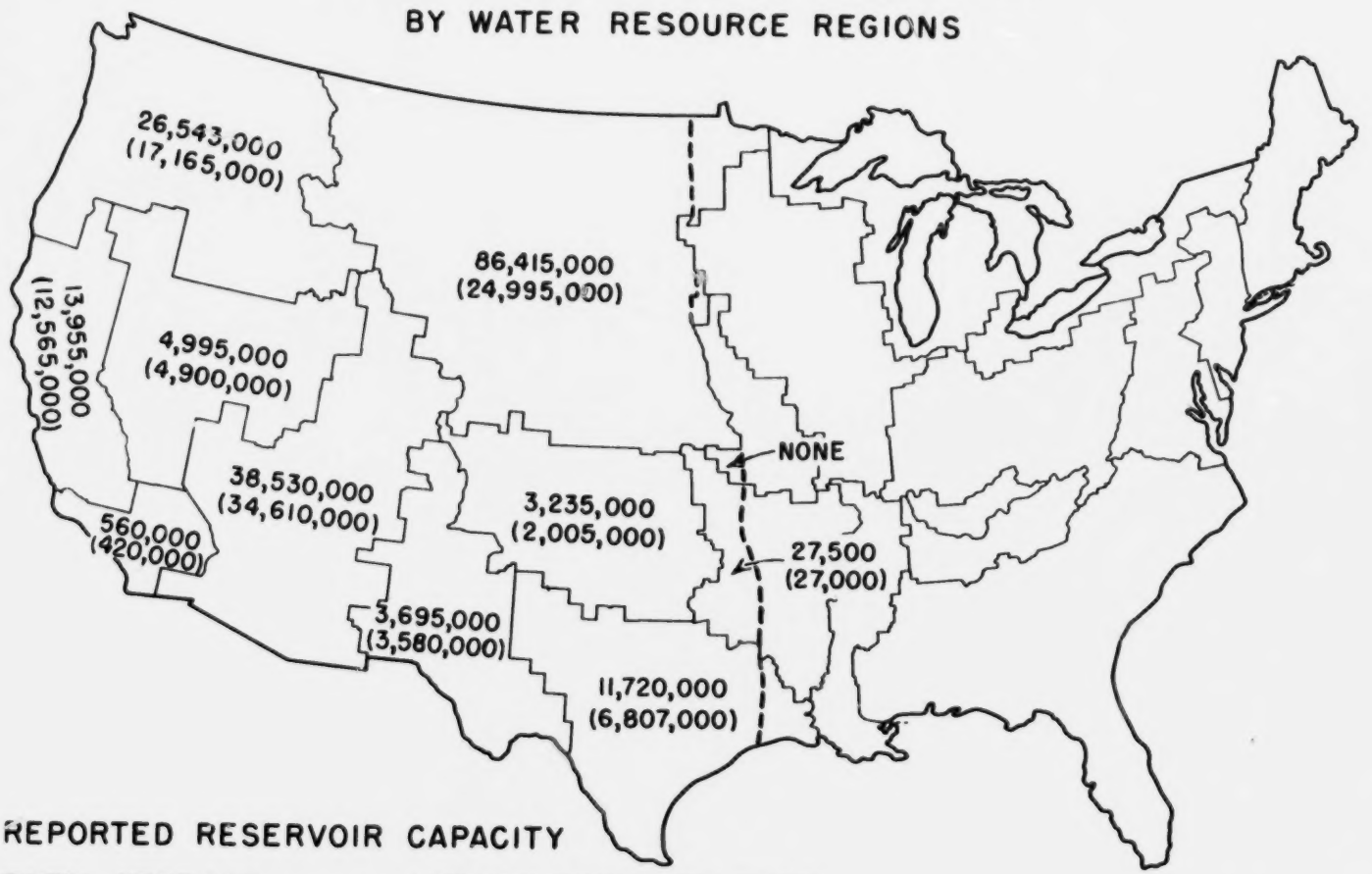
CAPACITY IN EXISTING RESERVOIRS SERVING IRRIGATION IN THE SEVENTEEN RECLAMATION STATES BY WATER RESOURCE REGIONS



REPORTED RESERVOIR CAPACITY

TOTAL STORAGE ..... 189,676,000 ACRE FEET

IRRIGATION STORAGE* ... (107,074,000 ACRE FEET)

(*) INCLUDING JOINT USE STORAGE

MAP 2

presently irrigated lands, this storage can support the future development of several million more acres. On the average, at least 10 acre-feet of storage are required for each acre of land irrigated from storage. The average annual diversion requirement is about 4 acre-feet per acre, so that much of the irrigation reservoir capacity involves holdover storage for service in years when streamflow is insufficient to refill the reservoirs.

Much of the irrigation storage space is used jointly with other purposes, especially power and flood control. Power uses over 100 million acre-feet, and flood control uses almost 40 million acre-feet of the total reservoir capacity. Such joint use provides the most efficient use of storage capacity. About 45 percent of existing storage capacity is in the upper Missouri Basin. The Colorado Basin has about 20 percent, and the Pacific Northwest has about 14 percent. The distribution of irrigation storage among water resource regions in the 17 reclamation States is shown on map 2.

Chapter III. Need for Future Development

What our country will be like in the future will determine what our needs for resource development will be 20 or 40 years from today. We can expect that the Nation's population will double in the next 50 years and that the combined growth rate of the 17 reclamation States will continue to exceed the national average. The present 43 million population of these Western States is expected to reach 108 million people in the year 2000. This growth in the 17 reclamation States will vary from region to region.

All river basins in the 17 reclamation States are likely to have a decrease in farm population and an increase in urban population. In the water-scarce West there will be relatively more pressure on water resources than in other sections of the country, although many areas in the humid and subhumid East and Midwest are feeling the pinch of water needs.

In the last decase the Nation has become sharply aware of the importance of water. Adequate municipal water supplies can no longer be taken for granted, and industry looks first for available water in seeking new locations for expanding its operations. In the humid and subhumid areas outside of the Western States, farmers are finding that 2 or 3 inches of additional moisture at critical times can make the difference between crop success and failure. Without an assured water supply, the parade of national growth will bypass some areas, but a harmonious combination of development of land and water resources will provide myriad opportunities for livelihood.

The doubling of the Nation's population in the next 50 years means that twice as much food and other farm products will be needed to maintain present dietary levels. Advancing standards of nutrition will call for more protective foods, especially for the elder and younger age groups. Present crop output will need to be doubled, and livestock products must be more than doubled.

The increasing population, moreover, will need living space. As it expands into the more sparsely populated areas, intensified resource use must provide the economic opportunities for such expansion and the economic base for improvement in the adequacy and quality of such cultural institutions as schools, hospitals, churches, and libraries.

Much of our present farmland, especially the more productive and level areas, is being lost to urban and other nonfarm uses. According to the Soil Conservation Service of the Department of Agriculture, an estimated 1.1 million acres of farmland are now converted annually to municipal, airport, highway, and other nonagricultural uses. In addition, some 700,000 acres of cropland are lost annually by soil erosion, tree planting, and waterlogging, raising the total loss to about 1.8 million acres per year. Technological developments, irrigation development, and other sources have approximately offset these losses so that harvested cropland has remained fairly constant at about 350 million acres over the last 40 years. This offset will not continue indefinitely. Although research and education will continue to improve the output from existing lands, gains become more difficult to realize as we reach higher plateaus of performance. Every avenue of improvement needs to be fully utilized.

The reclamation program as it seeks to open up new areas to settlement, promote economic growth and add elements of balance and stability to present agricultural and urban economies, and

to stimulate related non-Federal public and private investments furthers the many objectives involved in adequate provision for our expanding national and regional populations.

Looking to the turn of the century and the anticipated population growth by then, the attendant increase in needs for food and fiber and for new economic opportunities will require the greatest practical acreage of land in the West that can be reasonably and economically irrigated. There will be need also for maximum benefits flowing from municipal and industrial water supply, recreation, hydroelectric power, flood control, fish and wildlife, and all other benefits that are associated with and a part of multiple-purpose reclamation development.

Actions are being taken daily by various interests which are firmly committing the remaining water resources to particular uses. These actions need to be more systematically planned and coordinated in the future than in the past if they are not to interfere with optimum development in the public interest. Continuous surveillance of long-range overall future demands on water and a positive orderly program to meet these needs are required in future decades.

In considering the program of water resource development, the current "overproduction" of certain agricultural products should be appraised in light of both current and future requirements. The surpluses that currently exist are aggravated very little by the existing reclamation program, and the future water resource program must not be influenced by the prevailing temporary maladjustments. Of the more than 250 different commodities that farmers produce, only 20 are under any kind of price support program. Furthermore, only four crops make up the bulk of commodities in the Commodity Credit Corporation storage and loan program. These are corn, wheat, cotton, and tobacco; they constitute about 86 percent of the Commodity Credit Corporation holdings. It is estimated that irrigated farms receiving water from the Federal reclamation program are the source of less than 2 percent of this inventory. This proportion is so small because western-grown grains and forage are in strong demand locally and are used for feed on the irrigated farm or in the immediate locality. The specialty crops which constitute some 40 percent of the value of the reclamation harvest are of such quality or seasonal nature that they find an immediate market without subsidy.

The diverse and special character of the irrigation crop in the West is frequently ignored. More than 150 crops are grown on irrigated lands in the West, many of which are not produced elsewhere in commercial quantities. Additionally, the bulk of commercial production of many crops has gradually shifted to the irrigated lands of the West due to such factors as inherent productivity, the dry climate, and seasonal advantage.

Widespread misunderstanding exists as to the type of crops produced under irrigation and the complex nature of the total agricultural situation. There is a general belief in some areas that the current imbalances which exist in a few crops could be corrected by squeezing off water resource development in one section of the country.

Irrigation does not produce significant quantities of crops in surplus and actually reduces the output of these where water is brought to formerly dry farmlands. This is so because under irrigation farmers can diversify to crops which are more profitable and which are in current market demand. Also, the start of a project is not followed by crop production in significant quantity for some years due to the construction and development timelag. Major new land projects frequently take 15, 20, or 25 years to achieve full production.

At the rate of population growth of about 8,000 persons per day and the simultaneous daily loss of about 5,000 acres per day to noncrop uses, an overall agricultural crop surplus which is in the order of 5 percent of our annual production cannot be expected to prevail indefinitely. Here again it should be recognized that the current overproduction does not extend to all segments of the Nation's agriculture. There is in fact a need for bolstering production in many respects even today.

Chapter IV. Potential for Future Development

The amount of physically feasible water resource development remaining in the 17 reclamation States is large. This study has identified 1,085 potential projects, of which 650 have been classified as potential Federal projects. For the purposes of this report, the huge program visualized by the California State water plan is considered as one additional project, inventoried separately. There is some duplication in the data shown for the California State water plan and for other potentials in the central and southern Pacific water resource regions, but it is of relatively minor consequence. The locations of the potential projects are shown by river basins on the maps comprising appendix A. In total they represent, essentially, the remaining inbasin potential development of the West from present water supplies plus that development from interbasin transfers contemplated in the California State water plan.

The quality of data used to define the potential projects varies. About one-fifth of the projects are based on feasibility-grade data; about one-fourth are of reconnaissance grade, another one-fourth are rough estimates, and the remaining 30 percent represent judgment.

The estimated total cost for these 1,085 projects approximates $17.7 billion at 1959 prices. The potential Federal projects would cost $16.3 billion, and the non-Federal projects would cost $1.4 billion. The California State water plan would involve another $11.7 billion. Estimated total costs by water resource regions are shown in table 5.

Table 5. *Estimated total project cost of potential development, 17 reclamation States*

Water resource region	Total project cost	Federal projects	Non-Federal projects
Upper Rio Grande and Pecos	$251,000,000	$251,000,000	
Upper Missouri	4,058,000,000	3,923,000,000	$135,000,000
Lower Missouri (in Kansas)	10,000,000	10,000,000	
Upper Arkansas and Red	1,314,000,000	1,142,000,000	172,000,000
Lower Arkansas-Red-White (in Kansas, Oklahoma, and Texas)	257,000,000	246,000,000	11,000,000
Western Gulf	1,923,000,000	1,423,000,000	500,000,000
Colorado	3,311,000,000	3,300,000,000	11,000,000
Great Basin	693,000,000	598,000,000	95,000,000
Pacific Northwest	3,522,000,000	3,088,000,000	434,000,000
Central Pacific	2,258,000,000	2,208,000,000	50,000,000
South Pacific	127,000,000	115,000,000	12,000,000
Subtotal	17,695,000,000	16,275,000,000	1,420,000,000
California State water plan [1]	11,700,000,000		11,700,000,000
Total, 17 reclamation States	29,395,000,000	16,275,000,000	13,120,000,000

[1] Principally located in Central and South Pacific Basins.

This physical potential of land and water development is not confined to irrigation, as service to other purposes is contemplated wherever possible. In addition to serving irrigation, 185 would provide flood control, 163 can supply municipal and industrial water, and 46 have possibilities for power development. Practically all of the 573 projects requiring storage would involve fish and wildlife and recreation in varying degrees.

The potential developments inventoried would serve 14.6 million acres of land which are now uncropped or dry-farmed and 12.3 million acres of land in need of additional water supply.

In order to determine the equivalent in terms of new irrigated land previously uncultivated, an allowance has been made for the present production for lands now partially irrigated and lands now cropped but not irrigated. The new irrigated land equivalent thus determined amounts to 15.7 million acres as shown in table 6. The distribution of this new land equivalent is shown by water resource regions on map 3. The California State water plan would add another 5.9 million acres of new irrigated land equivalent for an overall total of 21.6 million acres.

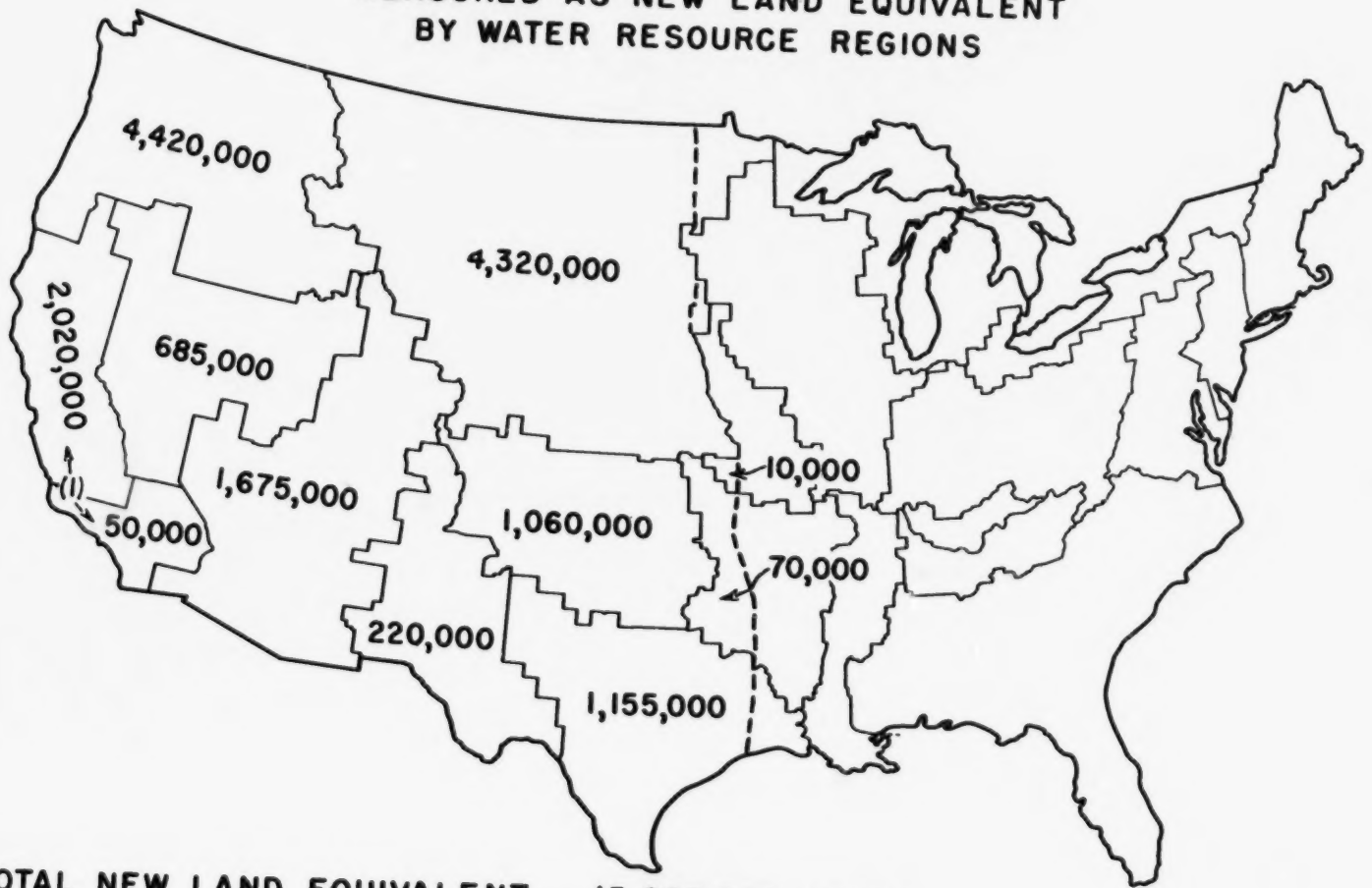
Table 6. *Acres included in potential projects, 17 reclamation States*

Water resource region	Newly irrigated land	Supplemental land	New land equivalent
Upper Rio Grande and Pecos	35,000	745,000	220,000
Upper Missouri	4,000,000	3,650,000	4,320,000
Lower Missouri (in Kansas)	20,000		10,000
Upper Arkansas and Red	970,000	665,000	1,060,000
Lower Arkansas-Red-White (in Kansas, Oklahoma, and Texas)	135,000		70,000
Western Gulf	1,970,000	750,000	1,155,000
Colorado	1,090,000	1,445,000	1,675,000
Great Basin	295,000	970,000	685,000
Pacific Northwest	4,685,000	1,790,000	4,420,000
Central Pacific	1,445,000	2,223,000	2,020,000
South Pacific	20,000	62,000	50,000
Subtotal	14,665,000	12,300,000	15,685,000
California State water plan	[1] 5,200,000	[1] 2,000,000	5,900,000
Total, 17 reclamation States	19,865,000	14,300,000	21,585,000

[1] Estimated on assumption that 50 percent of existing irrigation in Central and Southern Pacific Basins will ultimately need supplemental supply.

New land equivalent computed in the above manner is based on the production of fully irrigated lands. However, the addition of 3 acre of irrigated land in the West is, on an income basis, approximately equal to the addition of 3 acres of

POTENTIAL IRRIGATION ACREAGE IN THE SEVENTEEN RECLAMATION STATES MEASURED AS NEW LAND EQUIVALENT BY WATER RESOURCE REGIONS



TOTAL NEW LAND EQUIVALENT..... 15,685,000 ACRES

(1) DOES NOT INCLUDE 5,900,000 ACRES IN CALIFORNIA STATE WATER PLAN

MAP 3

average cultivated land. On this basis, the western irrigational potential, including that of the California State water plan, is equivalent to 64.8 million acres of average cultivated land.

Under existing procedures, about $12.7 billion of the total project cost of $17.7 billion, excluding the California State water plan for which a breakdown is not available, might reasonably be allocated to the irrigation function. This allocation represents an average cost of about $800 per acre of new irrigated land equivalent (not per physical acre actually to be irrigated). Average costs per equivalent acre within the individual water resource regions, of course, vary widely as shown in table 7. On chart 3 is shown the new irrigated land equivalent by construction cost per acre for the 17 reclamation States. Similar information broken down by water resource regions is shown on the charts comprising appendix B. All projects in a river basin will not be undertaken in the order of the lowest average cost as there are other factors that will affect selection.

TABLE 7.—*Allocated cost per equivalent irrigated acre, potential irrigation development, 17 reclamation States*

Water resource region	Cost allocated to irrigation	Average cost per equivalent acre
Upper Rio Grande and Pecos	$165,000,000	$750
Upper Missouri	[1] 4,395,000,000	[1] 1,017
Lower Missouri (in Kansas)	[2] 25,200,000	[2] 2,520
Upper Arkansas and Red	439,000,000	413
Lower Arkansas-Red-White (in Kansas, Oklahoma, and Texas)	39,600,000	566
Western Gulf	[2] 839,000,000	[2] 726
Colorado	2,231,000,000	1,332
Great Basin	307,200,000	580
Pacific Northwest	2,727,000,000	617
Central Pacific [3]	1,352,000,000	669
South Pacific [3]	76,000,000	1,520
Total, 17 reclamation States [3]	12,696,000,000	809

[1] Includes allocated storage cost from Corps of Engineers projects.
[2] Excludes unallocated storage cost from 17 projects.
[3] Data for California State water plan not available.

Map 4 shows that hydroelectric power can be developed at 46 potential projects having an aggregate capacity of about 5.5 million kilowatts. The California State water plan would add an additional 2.7 million kilowatts.

Total reservoir capacity at 573 potential projects, as shown on table 8, would exceed 150 million acre-feet, of which about 123 million acre-feet would be available for conservation storage primarily to serve irrigation, power, and municipal and industrial water supply. In addition, these reservoirs would provide over 23 million acre-feet of exclusive space for flood control and nearly 7 million acre-feet of reservoir capacity to be used jointly for flood control and conservation purposes. The distribution of total capacity is shown by water resource regions on map 5. The California State water plan would add 75.8 million acre-feet of additional total reservoir capacity.

The cost of conservation storage would require an investment of about $4.9 billion, out of the total project cost of $17.7 billion (table 8). This figure represents an average cost of $40 per acre-foot of storage, ranging from $20 per acre-foot in the Colorado Basin to $104 per acre-foot in the upper Rio Grande and Pecos River Basin. These figures represent the cost allocated to a share of reservoir capacity and should not be construed to mean that this amount of conservation space could be constructed separately, irrespective of other reservoir uses, at the cost shown.

TABLE 8.—*Reservoir capacity in potential projects involving irrigation, 17 reclamation States*

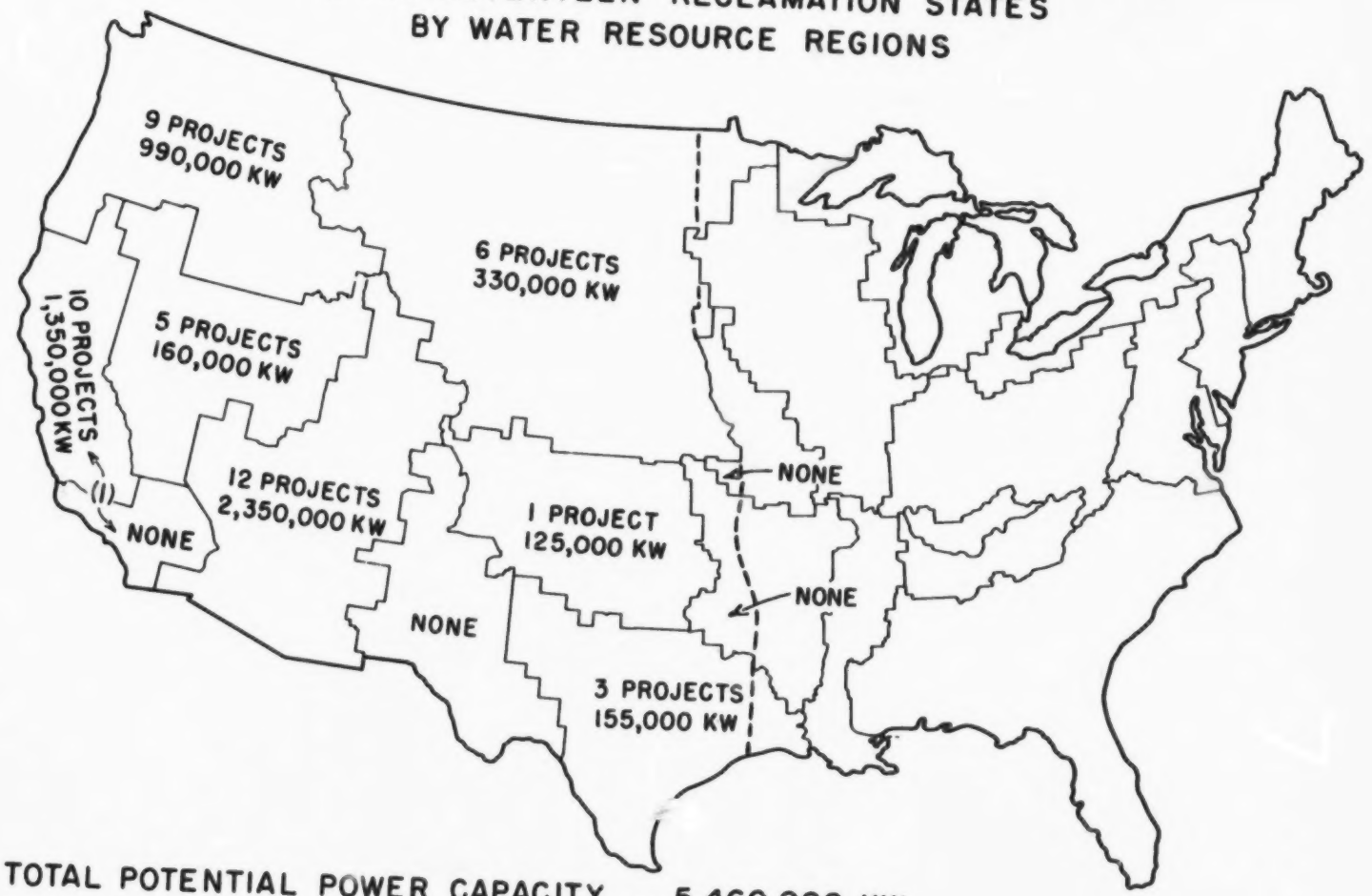
Water resource region	Total capacity (acre-feet)	Conservation storage [1] (acre-feet)	Cost allocated to conservation storage	Cost per acre-foot of storage
Upper Rio Grande and Pecos	1,650,000	1,115,000	$115,900,000	$104
Upper Missouri	17,000,000	11,100,000	776,000,000	70
Lower Missouri (in Kansas)	610,000	185,000	15,300,000	83
Upper Arkansas and Red	10,300,000	4,440,000	406,000,000	91
Lower Arkansas-Red-White (in Kansas, Oklahoma, and Texas)	5,670,000	2,410,000	110,000,000	46
Western Gulf	42,500,000	31,500,000	826,000,000	26
Colorado	48,000,000	46,900,000	937,000,000	20
Great Basin	3,550,000	3,540,000	188,800,000	53
Pacific Northwest	11,400,000	11,175,000	822,500,000	74
Central Pacific [2]	12,100,000	10,250,000	659,000,000	64
South Pacific [2]	820,000	700,000	63,500,000	91
Total, 17 reclamation States	153,600,000	123,315,000	4,920,000,000	40

[1] Includes storage primarily for irrigation, power, and municipal and industrial water supply.
[2] Data not available for 75,800,000 acre-feet in California State water plan.

The total conservation storage space of 123 million acre-feet in the 573 reservoir projects is estimated to be capable of producing almost 34 million acre-feet of annual water yield as shown in table 9. The California State water plan would add another 17 million acre-feet of annual water yield for a total of 51 million acre-feet.

The water yield of potential reservoirs, plus water derived from natural flows, return flows, ground water, and yield from existing storage would provide the water supply for irrigation of

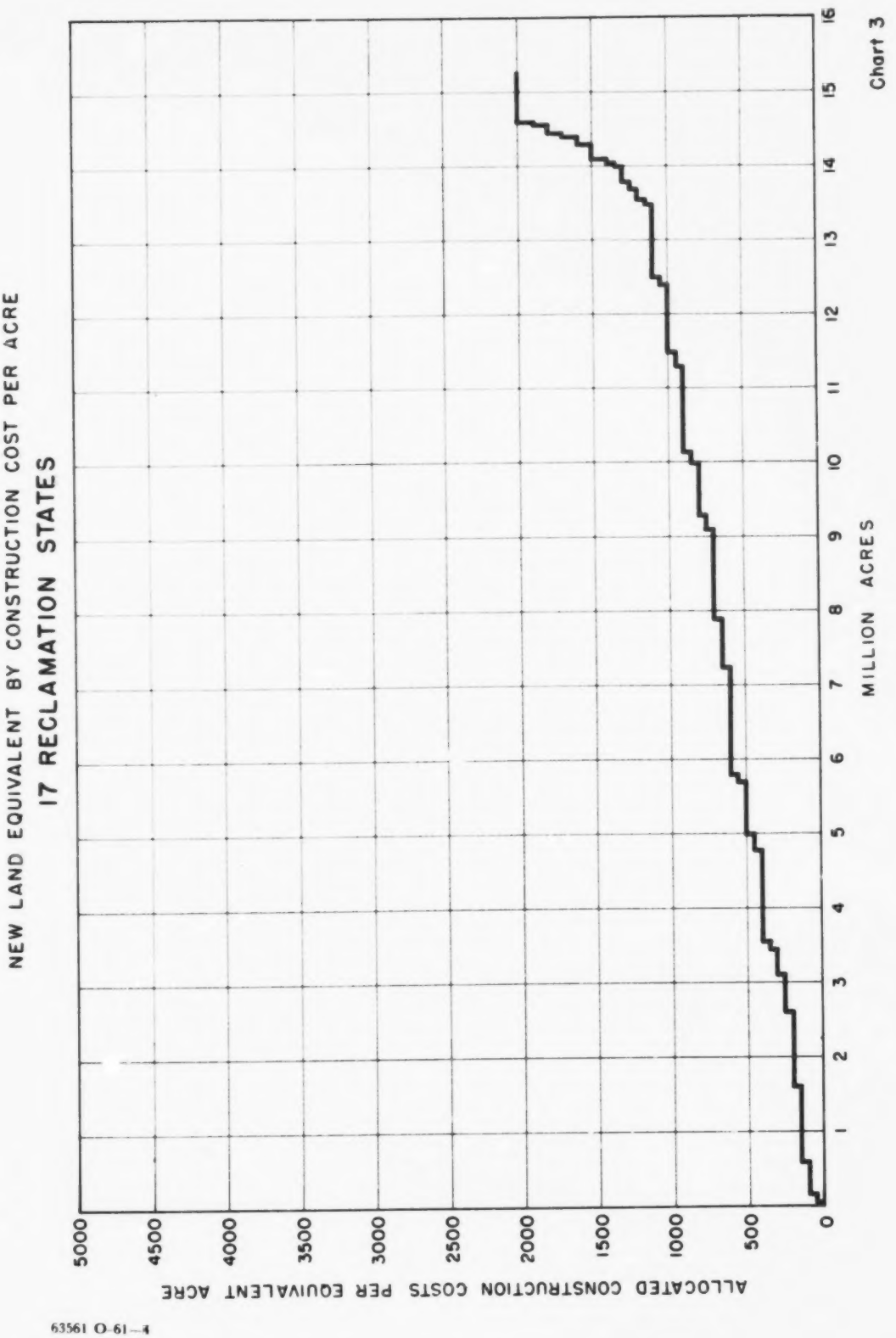
POWER CAPACITY AT POTENTIAL RECLAMATION PROJECTS IN THE SEVENTEEN RECLAMATION STATES BY WATER RESOURCE REGIONS



TOTAL POTENTIAL POWER CAPACITY..... 5,460,000 KW

(1) DOES NOT INCLUDE 2,740,000 KW CONTEMPLATED BY CALIFORNIA STATE WATER PLAN.

MAP 4


NEW LAND EQUIVALENT BY CONSTRUCTION COST PER ACRE
17 RECLAMATION STATES
ALLOCATED CONSTRUCTION COSTS PER EQUIVALENT ACRE
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
MILLION ACRES
Chart 3

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ACRE-FEET OF RESERVOIR CAPACITY
IN POTENTIAL PROJECTS INVOLVING IRRIGATION
IN THE SEVENTEEN RECLAMATION STATES
BY WATER RESOURCE REGIONS

TOTAL RESERVOIR CAPACITY.....153,600,000 ACRE FEET

(1) DOES NOT INCLUDE 75,800,000 ACRE FEET IN CALIFORNIA STATE WATER PLAN.

MAP 5

TABLE 9.—*Yield of conservation storage, potential projects involving irrigation, 17 reclamation States*

Water resource region	Average yield (acre-feet)	Cost per acre-foot of yield
Upper Rio Grande and Pecos	500,000	232
Upper Missouri	4,750,000	164
Lower Missouri (in Kansas)	[1] 45,000	340
Upper Arkansas and Red	[1] 1,350,000	301
Lower Arkansas-Red-White (in Kansas, Oklahoma, and Texas)	[1] 2,400,000	46
Western Gulf	[1] 11,660,000	71
Colorado	3,750,000	250
Great Basin	1,300,000	145
Pacific Northwest	3,800,000	216
Central Pacific	4,630,000	143
South Pacific	55,000	1,155
Subtotal	34,210,000	144
California State water plan	13,000,000	[2]
Total, 17 reclamation States	47,210,000	[2]

[1] Based on average yield in period of critical water supply.
[2] Data not available for California State Water Plan.

the potential acreage presented in table 6. The farm delivery requirements for irrigation of potential projects is estimated to average 3.26 acre-feet per equivalent acre, ranging from a minimum of 2.25 acre-feet per acre per year in the upper Missouri and upper Arkansas River Basins to 4 acre-feet per acre per year in the arid desertlike sections of the 17 reclamation States. The total estimated farm delivery requirement for all potential lands, including the California State water plan, is about 70 million acre-feet per year. The distribution of this amount as well as the average farm delivery requirement per acre for the several water resource regions is shown on table 10.

Since farm deliveries for irrigation are not consumed in their entirety, a portion of the unconsumed water returns to the stream or to ground-water basins and becomes available, in many cases, for reuse. Thus, the actual depleting effect of irrigation developments is normally less than the farm delivery requirement. In the case of the potential development discussed in this chapter, it has been estimated that the gross depletions to the overall water supply complex would be in the range of 60 million acre-feet.

TABLE 10.—*Potential average farm delivery requirement, 17 reclamation States*

Water resource region	Equivalent acres	Farm delivery requirement	Total acre-feet
Upper Rio Grande and Pecos	220,000	2.75	605,000
Upper Missouri	4,320,000	2.25	9,720,000
Lower Missouri (in Kansas)	10,000	2.50	25,000
Upper Arkansas and Red	1,060,000	2.25	2,385,000
Lower Arkansas-Red-White (in Kansas, Oklahoma and Texas)	70,000	2.50	175,000
Western Gulf	1,155,000	3.50	4,044,000
Colorado	1,675,000	3.50	5,863,000
Great Basin	685,000	4.00	2,740,000
Pacific Northwest	4,420,000	3.00	13,260,000
Central Pacific	2,020,000	4.00	8,080,000
South Pacific	50,000	4.00	200,000
Subtotal	15,685,000	3.00	47,097,000
California State water plan	5,900,000	4.00	23,600,000
Total, 17 reclamation States	21,585,000	3.30	70,697,000

CHAPTER V. PROJECTED FUTURE DEVELOPMENT PROGRAMS

The survey of more than 1,000 potential projects shows the magnitude of physical land and water resources available for development. It contains the raw materials from which a program of resource planning and construction for the next several decades may be selected. As program goals expand or change, the long-range program can be adjusted to conform with national policy. Needs and resources in each individual basin differ noticeably so that a projected development program should be built up by individual basins and portions of basins. The composite of regional program goals can be fitted to overall national requirements.

Chapter III, in discussing the need for future development, concluded that by the year 2000 the greatest practical acreage of land in the West that can reasonably and economically be irrigated will be needed. Proceeding from this conclusion, it is necessary only to decide what portion of the potential development set forth in chapter IV reasonably and economically could be realized by the year 2000 in order to visualize the scope and magnitude of a future reclamation program.

There are a number of factors that affect this decision. Certainly, it is unreasonable to expect that 100 percent of the full potential will ever be realized. The information presented in chapter IV reflects primarily the potential for irrigation development and does not take into account the probable extent of competitive uses of water. Uses of water primarily for municipal and industrial water supply, and for other purposes such as fish and wildlife, recreation, and pollution abatement will preclude development of a portion of the irrigation potential listed. Some potential projects included are too high in cost to be considered seriously in the foreseeable future. Others

will be blocked or delayed by lack of local support, water rights controversies, or other reasons. The projects susceptible to construction by non-Federal interests, with the exception of the California State water plan, are largely relatively simple ground-water undertakings similar to those that have flourished over the past decade and can be expected to develop at a faster rate than the more complicated storage projects.

Taking these factors into consideration, it is estimated that 90 percent of the non-Federal potential (excepting the California State water plan) and 75 percent of all other potential irrigation as outlined in chapter IV could be developed by the year 2000. A program to accomplish this would be made up as follows:

Category	Total project cost	New irrigated land equivalent	New land equivalent national average
	Millions	*Thousand acres*	*Thousand acres*
Non-Federal	$1,400	2,700	8,100
California water plan	8,600	4,800	14,400
Federal	12,000	9,500	28,500
Total	22,000	17,000	51,000

Of the $12 billion Federal program envisaged, projects totaling $1,200 million in cost are presently under construction.

The above program is possible and not unreasonable in the light of the Nation's growing needs. It represents a rate of irrigation development for Federal projects on an acreage basis of from 2 to 2½ times the rate for the past decade. The rate for non-Federal development probably will drop off sharply from that of the last decade, largely because the limit of new irrigation from ground water is rapidly being reached. For Federal projects, the cost per acre of new irrigated land equivalent would average $920 with the maximum values being in the $1,000 to $1,500 range. Such costs are not appreciably higher than those for many projects being undertaken today. In the past, cost per acre has always been reported on a physical rather than a productive equivalent acreage. The $920 average per equivalent acre cost can be considered to represent less than $600 per physical acre served.

Although the rate of future development will vary among river basins, for purposes of this report it is assumed that the relationship between actual development and potential will be uniform. There also will be a tendency to build the less expensive projects first, but the limit of accuracy of the cost estimates for long-range future projects does not justify adjustment for this factor. Thus, the cost associated with development of 75 percent of the potential acreage within a given basin is assumed to be 75 percent of the estimated cost of developing the full potential. Based on these assumptions, the future program for irrigation expansion showing costs, new land equivalents, water and storage requirements, water yields, and associated power and flood control improvements, all broken down by river basins, is presented in table 11.

Accomplishment of this program would approach full practical development of inbasin water supplies for irrigation in the West as now visualized, plus the interbasin water transfer projects contemplated in the California State water plan. There are other factors, however, which could well lead to further substantial expansion of irrigation.

Present research in the fields of evaporation reduction, phreatophyte control, and other means of water saving promise to lead to development of methods which could provide millions of more acre-feet of water for western use. Purification of saline water and weather modification also hold promise of substantial new sources of water supply. There are at least 25 million acres of land in the Pacific Northwest physically adaptable to irrigation which could be developed if sufficiently low-cost pumping energy or future price relationships permit economic development. In addition, transbasin diversions of water from such basins as the Columbia River and other north-coastal river basins which have water supplies far in excess of any foreseeable future consumptive demands comprise a major source of possible future irrigation expansion. The flows of these rivers presently escaping into the ocean average close to 300 million acre-feet per year. Their diversion, however, would be expensive and would involve many complicated interstate problems

TABLE 11.—*40-year program for irrigation development, 17 reclamation States*

FEDERAL (75 PERCENT OF TOTAL POTENTIAL)

Water resource regions	Total project cost	New land equivalent	Cost allocated to irrigation	Irrigation cost per equivalent acre	Farm delivery requirement		Consumptive use requirement		Total kilowatt capacity	Total reservoir capacity	Flood control space	Conservation storage	Yield from conservation storage
					Per acre	Total	Per acre	Total					
		Acres			*Acre-feet*	*Acre-feet*	*Acre-feet*	*Acre-feet*	*Kilowatts*	*Acre-feet*	*Acre-feet*	*Acre-feet*	*Acre-feet*
Upper Rio Grande and Pecos	$186,000,000	165,000	$123,700,000	$750	2.75	454,000	1.93	318,000		1,238,000	336,000	837,000	365,000
Upper Missouri	2,900,000,000	2,740,000	3,180,000,000	1,160	2.25	6,165,000	1.58	4,329,000	254,000	12,641,000	5,149,000	8,203,000	3,560,000
Lower Missouri [1]													
Upper Arkansas and Red	840,000,000	174,000	203,000,000	1,167	2.25	392,000	1.58	275,000	124,000	7,494,000	2,767,000	3,065,000	1,015,000
Lower Arkansas-Red-White	183,000,000	52,000	29,400,000	566	2.50	130,000	1.75	91,000		4,029,000	2,373,000	1,586,000	1,800,000
Western Gulf	1,050,000,000	796,000	581,100,000	730	3.50	2,786,000	2.45	1,950,000	142,000	21,659,000	5,088,000	14,889,000	5,940,000
Colorado	2,426,000,000	1,200,000	1,650,000,000	1,374	3.50	4,200,000	2.45	2,940,000	1,763,000	35,932,000	816,000	35,115,000	2,800,000
Great Basin	420,000,000	260,000	235,500,000	906	4.00	1,040,000	2.80	728,000	125,000	2,479,000		2,479,000	835,000
Pacific Northwest	2,275,000,000	2,650,000	1,710,000,000	646	3.00	7,950,000	2.10	5,565,000	750,000	8,334,000	3,837,000	8,166,000	2,630,000
Central Pacific	1,630,000,000	1,445,000	987,300,000	681	4.00	5,780,000	2.80	4,046,000	1,065,000	8,642,000	1,513,000	7,292,000	3,260,000
South Pacific	90,000,000	18,000	50,000,000	2,780	4.00	72,000	2.80	50,000		600,000	80,000	525,000	40,000
Total, Federal	12,000,000,000	9,500,000	8,750,000,000	921	3.05	28,969,000	2.14	20,292,000	4,223,000	103,048,000	21,959,000	82,247,000	22,245,000

NON-FEDERAL (90 PERCENT OF TOTAL POTENTIAL)

Upper Rio Grande and Pecos [1]													
Upper Missouri	133,000,000	603,000	120,700,000	200	2.25	1,357,000	1.58	953,000		32,000		32,000	16,000
Lower Missouri [1]													
Upper Arkansas and Red	170,000,000	731,000	151,600,000	207	2.25	1,645,000	1.58	1,155,000		315,000		315,000	48,000
Lower Arkansas-Red-White	11,000,000	[2]											
Western Gulf	493,000,000	88,000	58,000,000	659	3.50	308,000	2.45	216,000		268,000		268,000	100,000
Colorado	11,000,000	69,000	9,700,000	140	3.50	242,000	2.45	169,000		12,261,000	351,000	10,496,000	3,375,000
Great Basin	94,000,000	299,000	75,100,000	251	4.00	1,196,000	2.80	837,000		125,000		125,000	110,000
Pacific Northwest	428,000,000	802,000	388,400,000	484	3.00	2,406,000	2.10	1,684,000		221,000		221,000	195,000
Central Pacific	48,000,000	84,000	32,300,000	384	4.00	336,000	2.80	235,000		269,000	6,000	263,000	240,000
South Pacific	12,000,000	24,000	10,200,000	425	4.00	96,000	2.80	67,000		526,000	36,000	477,000	275,000
Subtotal	1,490,000,000	2,700,000	846,000,000	313	2.81	7,586,000	1.97	5,316,000		14,017,000	393,000	12,197,000	4,359,000
California State water plan [3]	8,600,000,000	4,800,000	(4)	(4)	4.00	19,200,000	2.80	13,440,000	2,057,000	56,875,000	(4)	(4)	13,000,000
Total, non-Federal	10,000,000,000	7,500,000	(4)	(4)	3.57	26,786,000	2.50	18,756,000	2,057,000	70,892,000	(4)	(4)	17,359,000
Total, 17 reclamation States, Federal and non-Federal	22,000,000,000	17,000,000	(4)	(4)	3.28	55,755,000	2.30	39,048,000	6,280,000	173,940,000	(4)	(4)	39,604,000

[1] No data reported or insignificant.
[2] Municipal water projects.
[3] 75 percent of total potential.
[4] Cost allocations and breakdown of reservoir capacity among functions are not available for California State water plan.

which would require long detailed negotiations and possibly interstate compacts for their solution.

The current research in water-saving devices promises to lead within the next 20 to 40 years to water savings in the West in the magnitude of at least 10 million acre-feet of water annually. Comparable projections for purification of saline water are not possible at this time nor can estimates be made for major interbasin water transfers over and above those contemplated in the California State water plan. It is evident, however, that in certain areas of the West there will still remain extensive sources of water supply undeveloped after the year 2000.

Chapter VI. Expected Accomplishments of Projected Programs

Accomplishment of the potential irrigation program outlined in chapter V would have widespread effects not only on the West but over the entire Nation. Some of the more important effects will be the promotion of economic growth of areas, production of food and fiber, improvement in the efficiency of resource use, prevention of economic decline, and the stimulation of diversified production.

It is impossible to predict exactly the agricultural pattern that would evolve or what the total production would be. To a large extent, the crops produced would depend upon market requirements. Because of the flexibility inherent in irrigated agriculture, irrigated lands can be quickly changed from one use to another, depending upon particular needs and circumstances.

The addition of 17 million acres of new irrigated land equivalent or 51 million acres of equivalent nonirrigated land would have a pronounced effect upon the Nation's potential to produce food and fiber to meet the requirements of an expanding population and of improved dietary standards. Cropland in use in the United States has fallen to the level of about 2 acres per person from a ratio of 3.7 in 1960. By the end of the century this country may be approaching the 1-acre-per-person status which now characterizes Europe even if foreseeable cropland additions are achieved. Thus, on a pro rata basis new land equivalent of 51 million acres assuming the present land-population ratio would provide the food and fiber for more than 25 million people. Advances in farm technology, such as improved seeds and fertilizers and better farming practices, can be expected to increase this figure significantly.

Assuming the same land-use pattern and the same yields as now exist under western irrigation, land use and crop production as indicated in table 12 would be achieved. It is significant that under this pattern of land use 63 percent of the irrigated land would be used for the production of feed grains and forage for livestock. The resulting livestock and livestock products would be extremely important in meeting the trend toward higher dietary standards.

Actually, the provision of this additional livestock feed and forage would have a greater effect on livestock production than indicated by the absolute amount of increased feed and forage production. The provision of a winter feed base would enable additional farms to go into livestock production and utilize presently available but unused pasture and forage for a large part of the livestock feed. During that part of the season when the other feeds are not available, crops grown under irrigation would supplement the pasture.

Table 12.—*Crop production of potential irrigation development, 17 reclamation States*

Crops	Equivalent acres [1]		Unit	Yield [2] per acre	Total production
	Number	Percent			
Corn	1,275,000	7.5	Bushels	69	88,000,000
Oats	340,000	2.0	do	47	16,000,000
Barley	986,000	5.8	do	45	44,000,000
Grain sorghum	1,275,000	7.5	do	54	68,850,000
Forage	204,000	1.2	Tons	15	3,060,000
Hay	6,375,000	37.5	do	2.6	16,600,000
Pasture	255,000	1.5	AUM	6.8	1,706,000
Wheat	901,000	5.3	Bushels	36	32,436,000
Rye	17,000	.1	do	19	323,000
Rice	459,000	2.7	Hundredweight.	34	15,600,000
Potatoes	391,000	2.3	do	175	68,400,000
Sugar beets	374,000	2.2	Tons	16.2	6,060,000
Sweetpotatoes	17,000	.1	Hundredweight.	85	1,450,000
Dry beans	459,000	2.7	Pounds	1,623	745,000,000
Soybeans	17,000	.1	Bushels	17	289,000
Cotton	1,598,000	9.4	Bales	1.69	2,700,000
Flaxseed	17,000	.1	Bushels	31	527,000
Peanuts	34,000	.2	do	42	1,430,000
Fruit	1,071,000	6.3	Dollars	560	600,000,000
Vegetables	748,000	4.4	do	340	254,000,000
Other	187,000	1.1	do	140	26,000,000
Total	17,000,000	100.0			

[1] Based on present cropping pattern.
[2] Based on present yields, future yields due to improved farm practices will be significantly greater.

Dietary trends of the American people have been steadily improved through the years. However, there remain important gaps to close if existing deficiencies are to be eliminated. The results of the latest dietary survey, published as the U.S. Department of Agriculture Circular, ARS 62-6, 1957, shows that more of the "protective" foods—fresh vegetables, fruits, meats, and dairy products—are required to meet adequate diet standards. Ten percent of our families had diets classed as "poor." Twenty-nine percent needed greater allowances of calcium, 25 percent needed more vitamin C, from 15 to 20 percent were below recommended levels of vitamin A, thiamine, and riboflavin.

Many of the specialty crops which can alleviate these nutritional shortages are most efficiently produced on the irrigated farms of the West where

growing conditions are particularly favorable. Many of the important specialty items in our diet are produced almost exclusively under irrigation. During the winter season when much of the Nation's farming area is blanketed with snow, the irrigated farms of the subtropical Southwest provide the fresh vegetables and fruits which are needed to balance and diversify diets the year around. Expansion in this important type of farming is necessary if we are to maintain even the present standard of diet while the population continues to increase.

Besides contributing to increased food and fiber production, the addition of the new irrigated land equivalent of 17 million acres would strengthen and give stability and diversity to the western economy. The entire Nation would gain in that unused resources would be utilized. The vast, underdeveloped regions of the arid and semiarid Western States need a productive resource base to enable these areas to contribute to the national wealth. Our rapidly expanding populace requires space in which to live and work—space that is habitable, well watered, and productive. The establishment of farms has always led to the growth of towns and finally to full-scale urbanization and industrialization. This is occurring throughout the Nation at a rate which causes more than a million acres of our farmland to be taken up by cities, factories, roads, and airports every year. Replacement of these lost acres and establishment of new nuclei for population centers are the pressing jobs for irrigation agriculture in the West.

The impact of the development of 17 million equivalent acres of new land is indicated in table 13. This table was based on the assumption that the new land would be developed and have the same characteristics as established irrigated communities. On the basis of these assumptions, the program would result in nearly 230,000 additional full-time farm units and an increase in farm population of about 800,000 people.

TABLE 13.—*Economic impact of potential irrigation development, 17 reclamation States*

Items	Unit	17 Western States	Upper Rio Grande and Pecos	Upper Missouri	Upper Arkansas and Red	Lower Arkansas-Red-White	Western Gulf	Colorado	Great Basin	Pacific Northwest	Central Pacific	South Pacific	California State water plan
New irrigated land equivalent	Thousand acres	17,000	165	3,343	905	52	884	1,260	559	3,452	1,529	42	4,800
New nonirrigated land equivalent	do	51,000	495	0,029	2,715	156	2,652	3,807	1,677	10,356	4,587	126	14,400
Full-time farms	Number	230,000	2,300	45,200	12,300	700	12,000	17,200	7,600	46,700	20,800	300	64,900
Irrigated farm population	do	800,000	7,900	157,400	42,900	2,400	41,600	60,000	26,300	162,500	72,300	1,100	225,900
Local urban population	do	2,400,000	23,600	472,500	127,800	7,300	124,800	180,000	78,800	487,600	216,500	3,300	677,600
Total local population	do	3,200,000	31,500	630,000	170,300	9,800	166,400	240,000	105,100	650,100	288,900	4,400	903,500
Local retail trade	Thousand dollars	4,100,000	40,300	807,300	218,300	12,500	213,200	307,500	134,600	833,000	370,200	5,600	1,157,500
Local retail enterprises	Number	41,000	400	8,080	2,180	120	2,130	3,080	1,350	8,330	3,700	50	11,580
Local retail payroll	Thousand dollars	412,000	4,050	81,120	21,930	1,260	21,420	30,900	13,530	83,710	37,220	550	116,310
Federal revenue collections	do	900,000	8,800	177,200	47,900	2,800	46,800	67,500	29,600	182,800	81,200	1,300	254,100

NOTE. Information for portion of lower Missouri Basin in Kansas not of sufficient significance to tabulate.

The opening of new farmlands through irrigation provides a stimulus to economic activity in the form of new job opportunities and incomes in related and dependent industries as is true of the development and utilization of any other natural resource. To market and process the products for final use by consumers, new facilities, new financing, and additional workers are called forth. To supply the basic producer with working capital, machinery, fuel, food, and fiber, demands are made against other basic resources. To accommodate this interindustry flow of goods, an array of intermediate businesses come into being—the shippers, wholesalers, retailers, bankers, communication workers, and dozens of others whose special services we can no longer do without.

The effect of a new aggregate of agriculture, business, and industry is to add another component of strength to the Nation's economy. In this particular case the retail element alone would support over 40,000 local retail enterprises typical of those now found in irrigated communities. These enterprises would support a payroll of over $400 million annually and do in excess of $4 billion of retail trade yearly. The magnitude of the increased local trade is illustrated by the fact that it represents a volume of trade greater than the current volume of exports of domestic agricultural

products of all kinds. Based upon existing agriculture-business relationships, the proposed irrigation program would support a local nonfarm population of about 2.4 million persons in the nearby towns and cities. The total increase in annual Federal revenue collections paid from such increased activity would amount to about $900 million.

The development of the potential program would have a wholesome and worthwhile effect on many isolated communities in the Western States. The filling in of the gaps and tying together of these communities creates the possibility for better and more economical government, better community services such as schools and hospitals, and improved living conditions in general.

Throughout the entire Nation the extended impact of reclamation development would be felt. Tractors, fuel, spare parts, tools, clothing, automobiles, and a myriad of industrial items would flow into these new farm areas. Traditionally, the bulk of the manufactured goods flow to the West from the industrialized East.

Chapter VII. Problems Requiring Attention

As the water resources of the West continue to be developed and the remaining water supplies become more and more limited, problems will arise that were not characteristic of earlier water development. Competition for water among various purposes, for instance, will become more acute and water-use planning must recognize desirable water-use priorities. Remaining developments, in general, will be more complicated and expensive, and the problems of economic justification and financing will need careful consideration. The relationships between Federal and non-Federal development undoubtedly will change and require changes in concepts as to the role each should play.

Many problems can be foreseen now if the program outlined in chapter V is to be accomplished. These problems fall generally into two groups—problems of cooperation and problems requiring further legislative guidance or changes in reclamation law. They will be discussed hereafter under these two headings.

Problems of cooperation

The Federal reclamation program is essentially a program of cooperation among the water users, the States, other Federal agencies, and the Bureau of Reclamation. Procedures for securing cooperation among the various interests involved have been developed and successfully applied in the past and will be continued in the future. Special problems, however, will arise. Some of the more important that can be foreseen are as follows:

Water exchanges.—Realization of a large part of the remaining irrigation potential of the West will depend upon working out effective water exchanges. The first irrigation diversions from a stream were generally made immediately below the mouth of the river canyon. Consequently, these areas generally have the best rights.

In many cases the better lands are further downstream or more remote from the channel. Experience has indicated that such lands could be irrigated by developing a source of additional water to supplement natural flow during years of average or below average runoff. This can often be done by holdover storage or ground water. However, in such cases, it is often desirable or necessary to divert flows or storage water belonging to older irrigated land higher up in the valley and replace this water with other storage or ground water. This requires the agreement and cooperation of existing water-right holders as well as the laws and the administrative tools not only to permit such exchanges but to set up effective methods for the administration of such exchanges.

Water users are often reluctant to exchange a surface water supply for one in the ground which they cannot see, or for a substitute surface water supply, even though it is of equal or better quality and reliability. The perfection of State water laws in respect to ground water codes would be of material aid in working out the solutions to such problems.

Watershed protection and land treatment versus downstream water uses.—The program of the Department of Agriculture under Public Law 83–566 may eventually result in extensive improvements on small watersheds for the control and retardation of runoff. There is at this time no uniform agreement among technical experts as to the overall effect of such improvements on

downstream water supplies. Hence, a basis for possible conflict over water supplies may be in its early stages of development.

A cooperative study by the Soil Conservation Service, Agricultural Research Service, and the Bureau of Reclamation is now underway to develop methods of measuring the impact of watershed protection and land treatment programs on downstream basin water supplies that will have widespread technical acceptance and application. It is anticipated that this cooperative study will require a period of at least 3 more years beyond the 2 years it has now taken. It should be continued and intensified if necessary to an acceptable conclusion as early as practical.

California State water plan.—The $12 billion California State water plan is treated in the foregoing chapters as a proposed non-Federal development. Undoubtedly, however, there will be some measure of Federal participation. In any event, the works proposed under that plan and those of the existing and projected Federal Central Valley project will be mutually complementary and may well involve joint works and facilities. Close, continuing cooperation between the State of California and the Federal Government will be essential to keep their respective programs in harmony.

Corps of Engineers-Bureau of Reclamation cooperation.—Because both agencies are involved in multiple-purpose river basin development in the West, their programs have many similarities. Over past years through formal agreements on division of responsibilities in several major basins and by other means, procedures for coordination have been worked out that are quite satisfactory today. This coordination must be continued in the interests of efficient resource development.

Colorado River Basin.—The long-range excess of water demand over water supply in the basin, the circumscriptions of existing interstate compacts, and the controversies over compact interpretation as typified in the present litigation before the Supreme Court entitled "*Arizona* v. *California, et al.*, No. 9 Original" all point to the coordination among the Federal Government, the States, and other basin interests in the future development of the water resources of the Colorado River Basin.

Dams versus fish.—The program of development contemplated in chapter V is certain to contain projects which will involve conflicts of interest over preservation of streams for fisheries and development for other purposes. Great strides have been made in the past decade in providing for the preservation and enhancement of fish and wildlife at Federal water resource undertakings including intensified research on the problem of passing anadromus fish past dams. The problems of the future, which may intensify as water supplies are more fully used, will require exacting coordination in their solution.

Desirable changes in reclamation law

Reclamation law, since the original Reclamation Act of 1902, has not been static, but has been amended and added to from time to time as the needs for resources development required. Reclamation law, as it evolved, has been adequate as the basis for the Federal reclamation program. Future changes and additions, however, appear inevitable as complete development of western water resources is more nearly approached. This, in turn, will involve more expensive projects, changing patterns of water use, changing patterns of Federal, State, and local responsibilities, and other factors. Some of the more important areas in which desirable amendments to reclamation law can be foreseen are as follows.

Basin accounts.—Basin accounts which provide for financial assistance from power and municipal and industrial water supply revenues on an area-wide basis in the repayment of irrigation costs beyond those which can be repaid by the irrigation water users are now operating successfully in the Missouri, Central Valley, and upper Colorado River Basins. There is need for such accounts in other areas, particularly the Pacific Northwest at this time. It may be desirable in future years to consider the establishment of a westwide account which would cover all of the reclamation States.

Interest rates.—At present, several formulas and criteria have been established by separate acts of the Congress for determining the interest rate for reimbursable functions. In the planning of reclamation projects, an interest rate of 2.5 percent is generally used in the economic analysis. In repayment, however, the rate may vary from 2.5 to 4.25 percent depending upon the applicable legislation. Furthermore, the interest rate for separate projects of the Upper Colorado Storage and Participating Projects and for projects under the

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small reclamation projects program may fluctuate quite markedly from year to year due to the nature of the formula specified for determining applicable interest rates. As all reclamation projects reflect essentially the use of Federal funds, there appears to be little equity in the imposition of widely varying interest rates for similar projects. Standardization of interest rate requirements is advisable.

Recreation.—During the past decade, the recreation use of reclamation reservoirs has been growing at a tremendous pace. Every indication, such as the expanding population, more leisure time, better transportation facilities, and higher living standards, points to a continuation and even increase in this growth in recreation use. Many of the older reclamation projects are seriously deficient in even minimum health and protective facilities to accommodate the great number of visitors that now come to these water areas for recreation.

Projects authorized in recent years generally have had minimum basic facilities authorized at Federal expense, and in some instances, more elaborate facilities have been authorized. There is, however, no basic provision in reclamation law to accommodate recreation, and it is now handled on a project-by-project basis. There is urgent need for uniform Federal law and policy in this field to establish the extent of Federal responsibility in providing for recreation at Federal water resource development projects.

Fish and wildlife.—Although the Fish and Wildlife Coordination Act of 1958 went a long way toward defining Federal responsibility for fish and wildlife at Federal projects there is still need for a uniformly accepted Federal policy delineating the extent to which the Federal Government should contribute to the cost of both specific and joint features for the improvement of fish and wildlife at Federal projects.

Extension of reclamation law to other States.—During the past two decades, irrigation practices have been spreading rapidly throughout many of the Eastern States as the value of controlled water applications to crops become more and more recognized. This trend will surely continue, and although for the next decade the growth of irrigation will be largely through individually financed endeavors, the time will come when more elaborate project-type facilities will be required and in demand. Such possibilities are even now being discussed in some States. At such time as the Federal Government becomes involved, consideration should be given to extending reclamation law and policy eastward.

Chapter VIII. Summary and Conclusions

Irrigation has played an extremely important role in the development of the West. It provided the means for making many areas of the West suitable for settlement, and it created a frontier in which people could find opportunity for profitable self-employment. With irrigation came many attendant benefits such as highways, railroads, schools, and community integration and development. Numerous vital centers throughout the West owe their present existence almost exclusively to irrigation.

Included among such centers are the Boise Valley of Idaho; the Yakima Valley in Washington; the Central Valley of California; the Rio Grande Valley of Colorado, New Mexico, and Texas; the Phoenix area of Arizona; the Yuma, Imperial, and Coachella Valleys of Arizona and California; the Salt Lake City area of Utah; the North Platte River Valley of Nebraska and Wyoming; and many others. Irrigation in the West has also provided a winter feed base which is necessary for the utilization of adjacent rangelands to which the Nation looks for a significant part of its meat supplies. It is an underlying activity basic to the economy of the West.

In 1958 there were about 34 million acres of irrigated land in the United States, of which some 30.5 were in the 17 reclamation States. Of the 30.5 million acres, about 24 million are dependent upon privately developed facilities and 6.5 million upon federally constructed works. More than 80 percent of private development has been from natural flows and ground water with the remaining from reservoir storage. The limit of development from simple gravity diversion of natural flows has for all practical purposes been reached, and the remaining potential irrigation expansion from ground water is relatively small. Thus, signifi-

cant future expansion of irrigation in the West will depend primarily upon the more expensive reservoir storage and high-lift pumping type developments characteristic of the Federal reclamation program and the proposed California State water plan.

The doubling of the Nation's population in the next 50 years means that twice as much food and other farm products will be needed to maintain present dietary levels. Advancing standards of nutrition will call for more protective foods. Present crop output will need to be doubled and livestock products more than doubled. The present transitory overproduction of certain crops upon which new irrigation has little if any effect will cease to exist, and there will be a demand for the maximum output that can be secured from the agricultural plant. The increasing population, moreover, will need living space and economic opportunities. The entire economic base of the West will need to be broadened if it is to absorb and provide for its share of the expected population growth.

Irrigation expansion can contribute importantly to all of these objectives. Looking to the year 2000, the foreseeable needs for food and fiber and new economic opportunities will require the greatest practical acreage of land in the West that can be reasonably and economically irrigated. There will be need also for the benefits flowing from hydroelectric power, flood control, municipal and industrial water supply, recreation, fish and wildlife, and all other functions that are associated with and a part of reclamation development.

The amount of physically feasible water resource development remaining in the 17 reclamation States is enormous. The potential projects for which data are summarized in this report would about double the production from presently irrigated lands in the West, providing a full irrigation supply for 19.9 million acres and a supplementary irrigation supply for 14.3 million acres. In total they represent essentially, except for the Pacific Northwest, the remaining inbasin potential irrigation development of the West from present water supplies plus that development from interbasin water transfers contemplated in the California State water plan.

Over and above this potential lies that which could be made possible from evaporation reduction, phreatophyte control, and other means of water saving, which could free up to 10 million acre-feet of water annually in the West within the next 20 to 40 years. Purification of saline water and weather modification also hold promise of substantial new sources of water supply. At least 25 million additional acres of land in the Pacific Northwest are physically susceptible to irrigation if economic conditions permit their development. Transbasin diversions of water from such basins as the Columbia River and other north-coastal streams which have water supplies far in excess of any foreseeable demands comprise a most important source of possible future irrigation expansion. The flows of these rivers presently escaping into the ocean average close to 300 million acre-feet per year. Their diversion, however, would be expensive and would involve many complicated interstate problems which would require long detailed negotiations and possibly interstate compacts for their solution.

Development of the full physical irrigation potential of the West will never be realized, as factors such as excessive cost, competition by other functions for water, lack of interest, and limitations on water export will always preclude some potential development. It appears reasonable and within economic reality, however, that of the 1,085 projects summarized in this report, 75 percent of the Federal projects and 90 percent of the non-Federal projects could be developed by the year 2000. Such a program would provide for the irrigation of 17 million acres of new irrigated land equivalent at an estimated cost of $22 billion broken down as follows:

Category	New irrigated land equivalent	National average cultivated land equivalent	Total project cost
	Thousand acres	*Thousand acres*	*Millions*
Federal	9,500	28,500	$12,000
Non-Federal	2,700	8,100	1,400
California State water plan	4,800	14,400	8,600
Total	17,000	51,000	22,000

Whereas about 80 percent of existing irrigation was developed by non-Federal interests and 20 percent through the Federal reclamation program, this program would on an acreage basis call for 16 percent non-Federal development, 56 percent Federal development, and 28 percent through the

California State water plan. It is expected that Federal participation in the California State water plan would be justified and forthcoming to some degree. The rate of new irrigation development would not be significantly greater than over the past 40 years, but there would be a decided shift in emphasis from non-Federal to Federal-type developments.

The impact of such a projected program on the West and on the Nation would be impressive. In measurable terms it would accomplish or lead to the following:

1. Provide food and fiber for 25 million people based on present-day production levels. Improved farm practices can be expected to increase this significantly.

2. Provide 230,000 additional full-time family-size farm units and an increase in farm population of 800,000 people.

3. Support a local nonfarm population of 2.4 million persons.

4. Support over 40,000 local retail enterprises that would do in excess of $4 billion in retail trade annually.

5. Increase annual Federal revenue collections by about $900 million.

Additional benefits not measurable in specific terms would include the following:

1. Expansion of the winter feed base of the West to permit more efficient use of pasture and rangelands for livestock production.

2. Production of specialty crops and "protective" foods required to meet increasingly higher national dietary standards.

3. Opening of new living space for the Nation's rapidly expanding population.

4. Provision of significant recreation and fish and wildlife benefits which are becoming of ever-increasing national importance.

As the water resources of the West continue to be developed, the remaining water supplies will become more and more limited, and problems will arise that were not characteristic of earlier water development undertakings. If the program outlined herein is to be accomplished, major problems that can now be foreseen and which will require special attention include the following:

1. Full, efficient utilization of the water resources of the West will require significant changes in the existing pattern of water use. Many potential projects will require the negotiation of water exchanges in which holders of existing water rights will accept substitute water supplies. This will involve extensive negotiations with water users as well as the laws and administrative tools not only to permit such exchanges but to set up effective methods for the administration of such exchanges. The perfection of State water laws in respect to ground water codes would be of material aid in working out solutions to such problems.

2. The extension of the basin account principle for providing financial assistance to irrigation, now in effect in the Missouri, upper Colorado, and Central Valley Basins, to other areas of the West is almost a prerequisite under present reimbursement requirements to accomplishment of the future Federal reclamation program envisioned. The eventual establishment of a westwide account to cover all of the reclamation States may well be desirable.

3. The uncertainties with respect to the effects of the watershed protection and land treatment programs of the Department of Agriculture on river basin water supplies must be resolved by continued research and cooperative actions to insure acceptable evaluation of future available water supplies.

4. Cooperation between the Federal Government and the State of California on a scale heretofore unexperienced will be essential in the development of the vast $12 billion State water plan and in the expansion of the Federal Central Valley project. Cooperation among the various water resources agencies of the Federal Government and with State and local agencies must be continued and improved where necessary as competition for remaining unused water supplies intensifies.

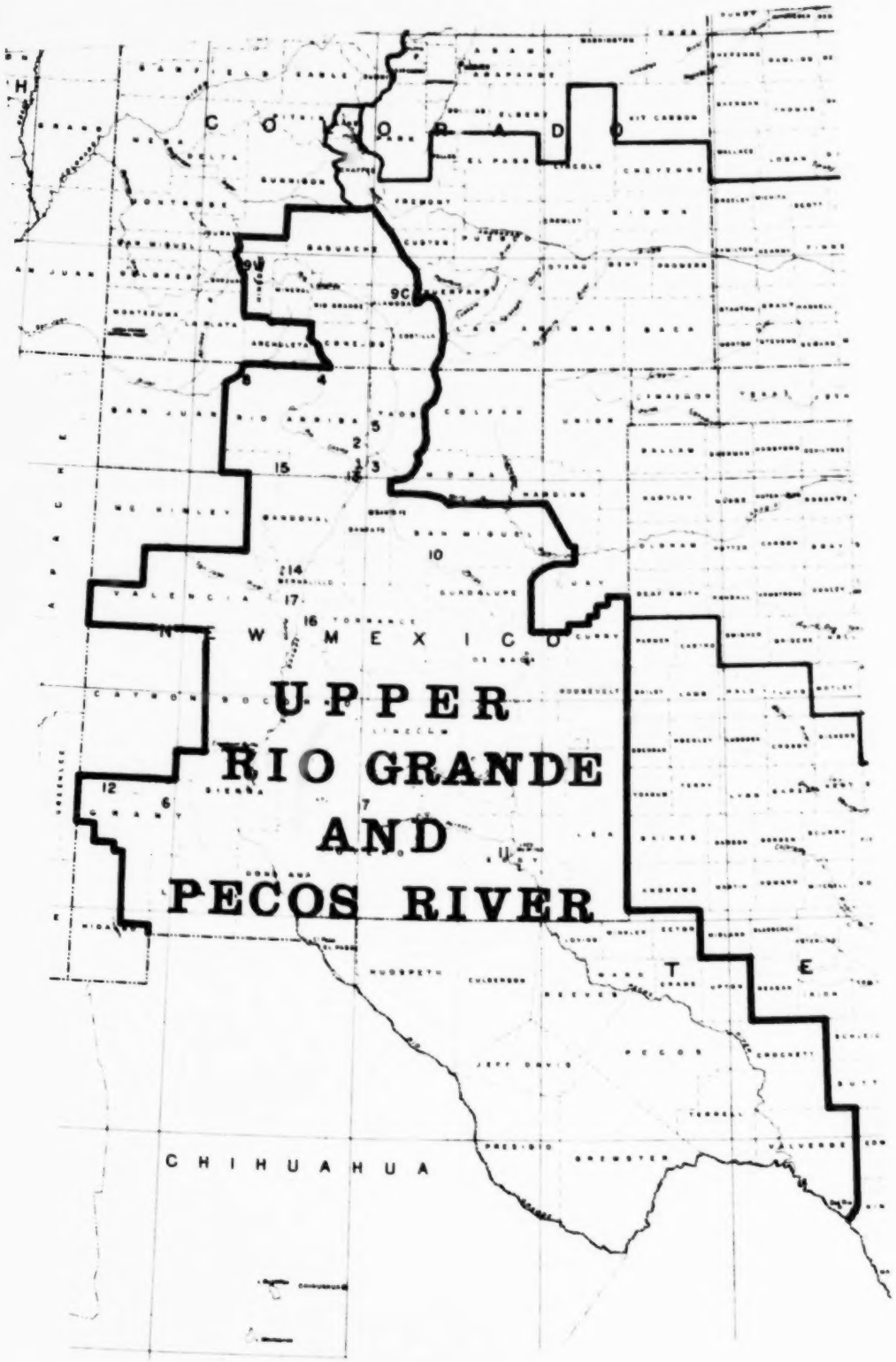
5. Clarification of Federal policy on several items such as interest rates, standards of economic analysis, and extent of responsibility for provision of recreation and fish and wildlife facilities at Federal undertakings are urgently needed now and will become of even more importance in the future.

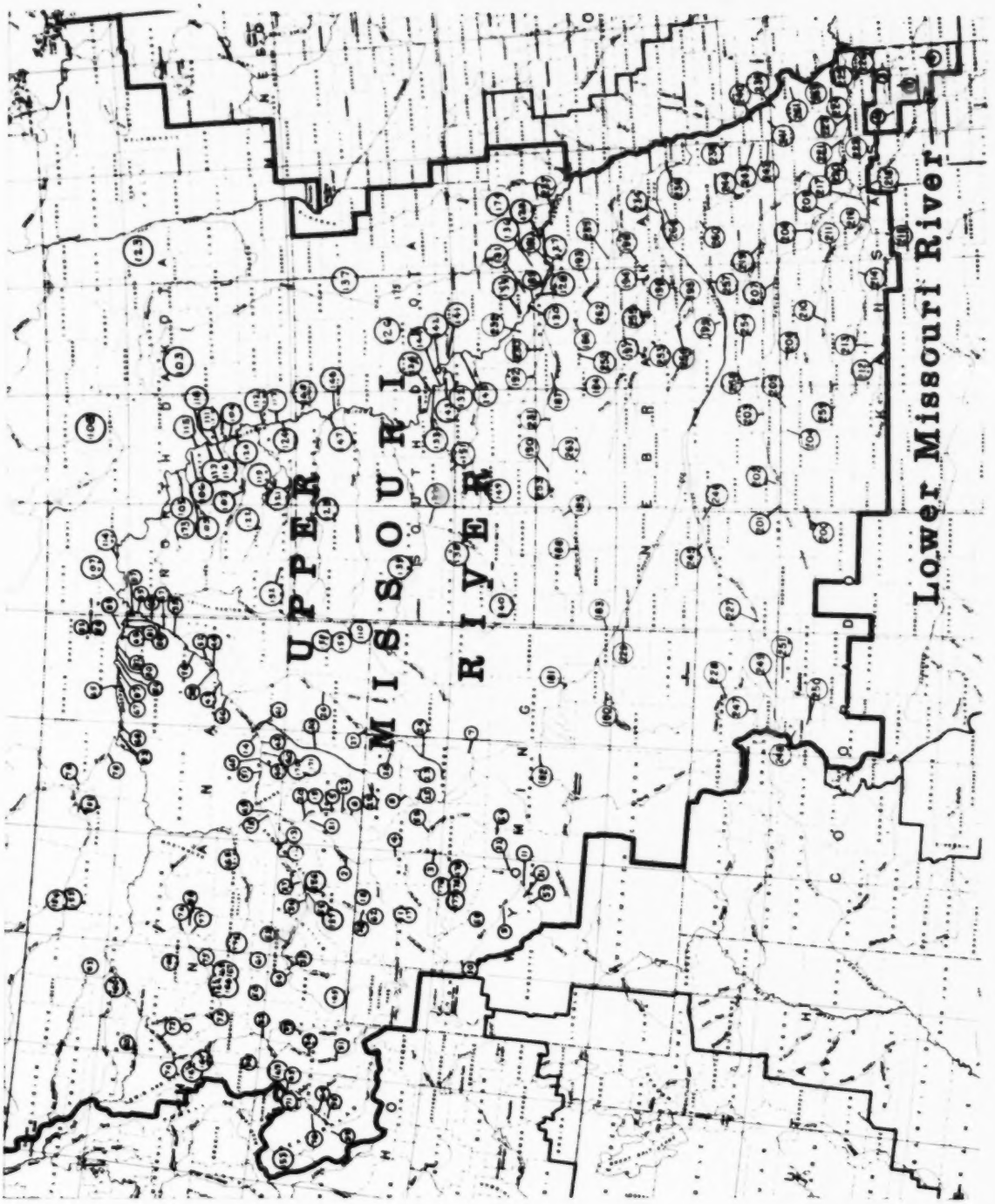
6. The rapid growth of irrigation in the Eastern States during the past two decades presages the time when the Federal Government may become involved to a major extent. At such time consideration should be given to extending reclamation law and policy eastward.

APPENDIXES

Appendix A

Potential Project Location Maps by Water Resource Regions

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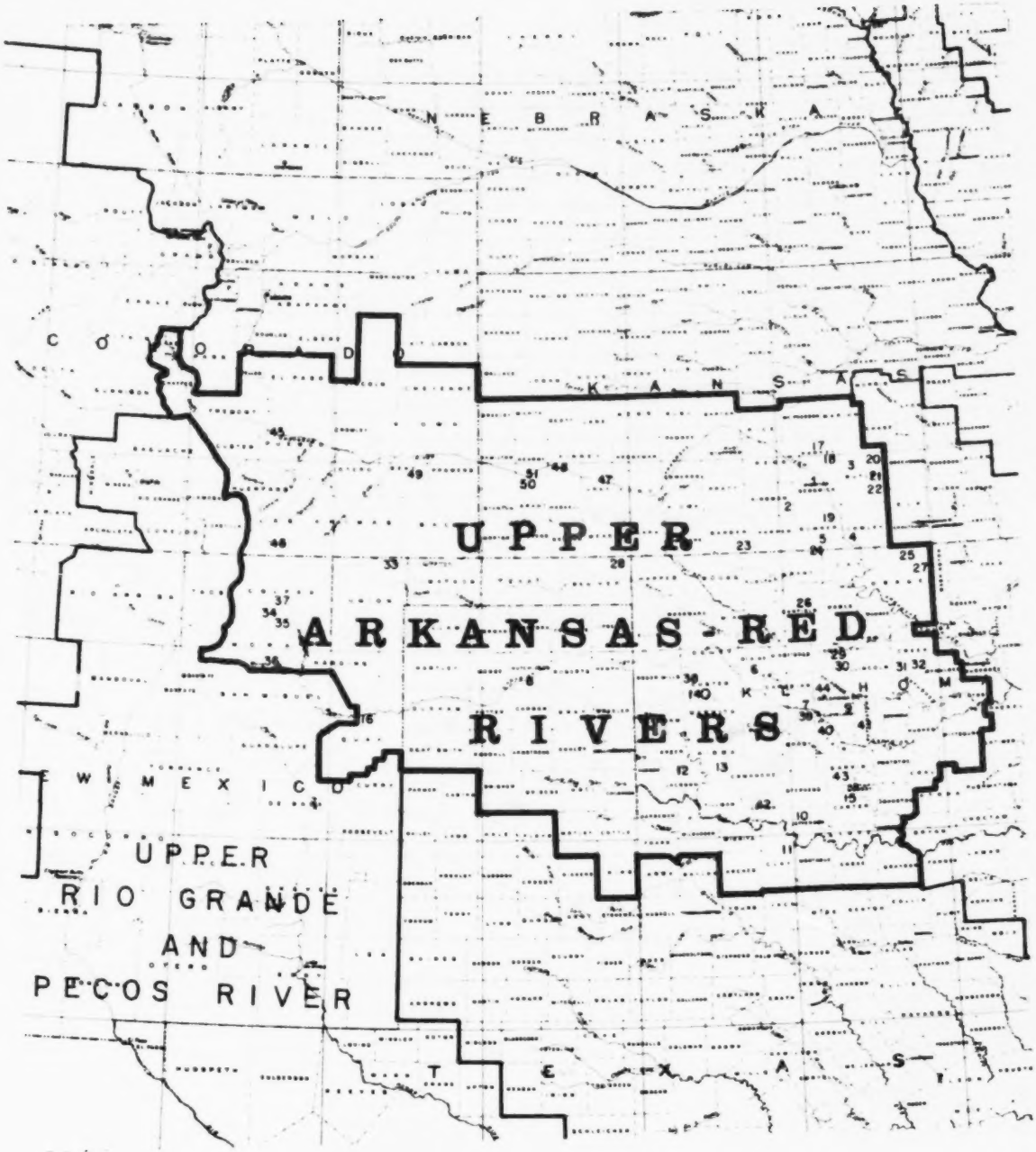
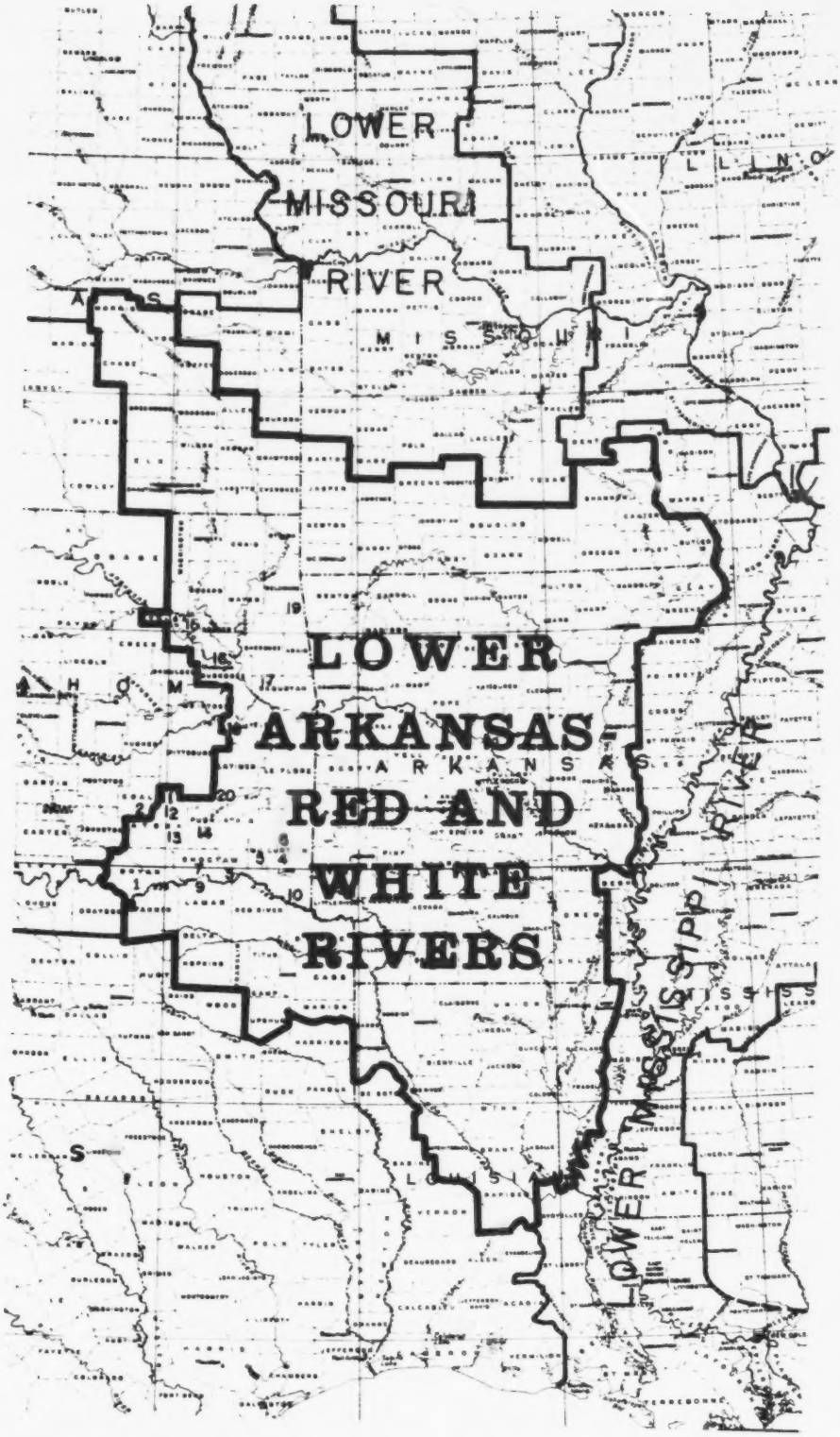
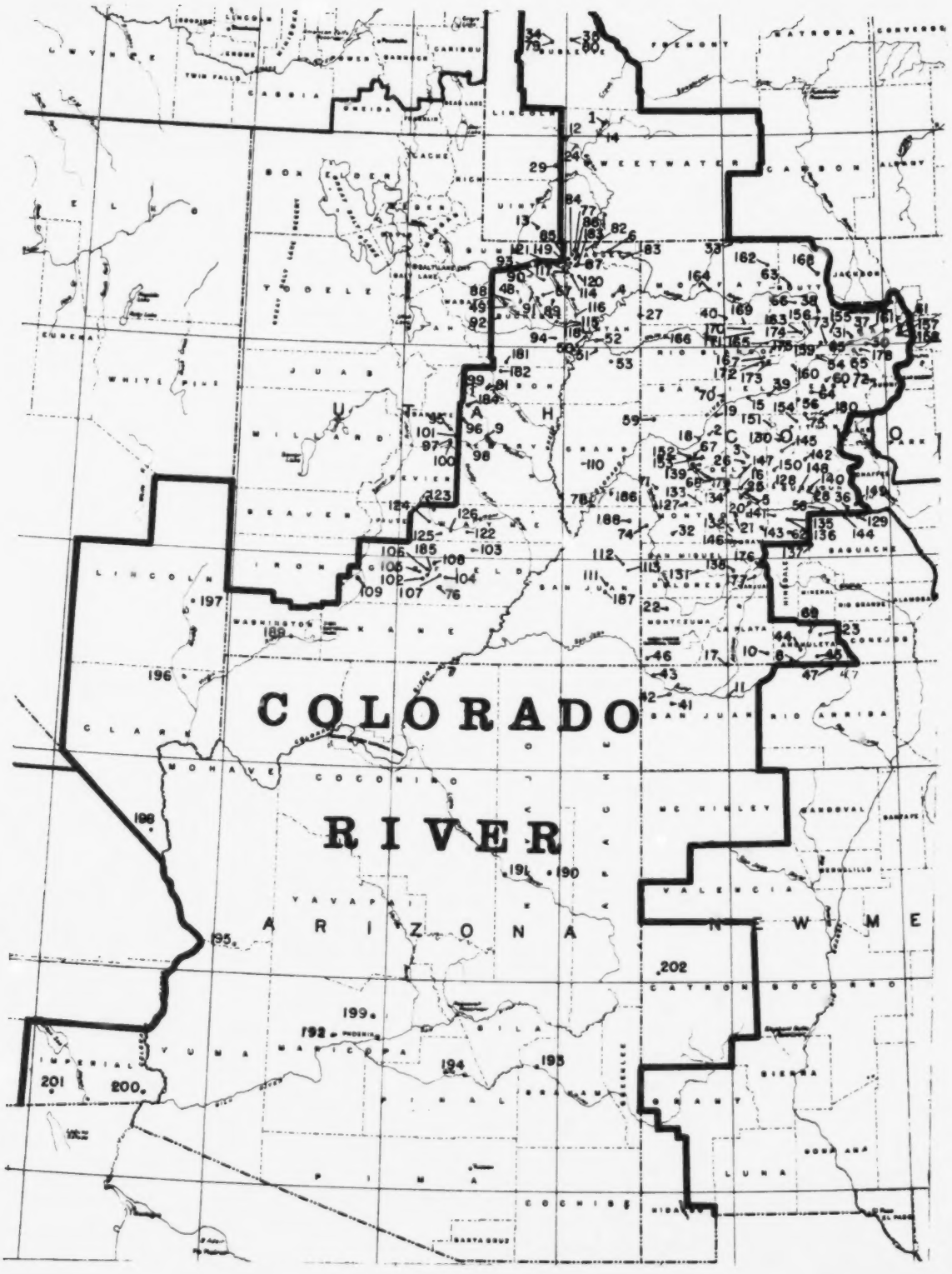
Lower Missouri River


NEBRASKA
COLORADO
KANSAS
UPPER
ARKANSAS-RED
RIVERS
NEW MEXICO
UPPER
RIO GRANDE
AND
PECOS RIVER
TEXAS


LOWER
MISSOURI
RIVER
LOWER
ARKANSAS-
RED AND
WHITE
RIVERS
ARKANSAS
MISSOURI
LOWER MISSISSIPPI RIVER

OKLAHOMA
ARKANSAS
WHITE RIVERS
TEXAS
WESTERN
GULF
COAHUILA
ZACATECAS


COLORADO
RIVER
ARIZONA
NEW MEXICO
UTAH
WHITE PINE
JUAB
MILLARD
BEAVER
IRON
LINCOLN
WASHINGTON
KANE
GARFIELD
PIUTE
SEVIER
SANPETE
EMERY
GRAND
SAN JUAN
MONTEZUMA
LA PLATA
ARCHULETA
CONEJOS
RIO ARRIBA
SANDOVAL
MC KINLEY
VALENCIA
SOCORRO
CATRON
SIERRA
LUNA
DONA ANA
OTERO
CHAVES
EDDY
LEA
ROOSEVELT
CURRY
QUAY
HARDING
SAN MIGUEL
MONTROSE
OURAY
SAN JUAN
DOLORES
MINERAL
HINSDALE
RIO GRANDE
ALAMOSA
COSTILLA
SAGUACHE
CHAFFEE
LAKE
PARK
TELLER
EL PASO
PUEBLO
CROWLEY
OTERO
KIOWA
BENT
PROWERS
BACA
LINCOLN
CHEYENNE
KIT CARSON
YUMA
PHILLIPS
SEDGWICK
LOGAN
WASHINGTON
MORGAN
ADAMS
ARAPAHOE
KIOWA
CHEYENNE
KIT CARSON
LINCOLN
ELBERT
EL PASO
PUEBLO
CROWLEY
OTERO
KIOWA
BENT
PROWERS
BACA
CUSTER
HUERFANO
LAS ANIMAS
BACA
PARMER
CASTRO
DEAF SMITH
OLDHAM
RANDALL
POTTER
CARSON
ARMSTRONG
DONLEY
COLLINGSWORTH
GRAY
WHEELER
HEMPHILL
ROBERTS
HUTCHINSON
MOORE
HARTLEY
OCHILTREE
LIPSCOMB
SHERMAN
HANSFORD
HOCKLEY
LUBBOCK
LAMB
BAILEY
COCHISE
GRAHAM
GREENLEE
SANTA CRUZ
PIMA
PINAL
GILA
MARICOPA
YAVAPAI
MOHAVE
COCONINO
NAVAJO
APACHE
GRAHAM
GREENLEE
SANTA CRUZ
COCHISE
PIMA
PINAL
GILA
MARICOPA
YUMA
IMPERIAL
SAN BERNARDINO
RIVERSIDE
ORANGE
LOS ANGELES
VENTURA
SANTA BARBARA
SAN LUIS OBISPO
KERN
TULARE
KINGS
FRESNO
MADERA
MARIPOSA
MONO
INYO
SAN BENITO
MONTEREY
SAN LUIS OBISPO
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
RIVERSIDE
SAN BERNARDINO
IMPERIAL
YUMA
MARICOPA
PINAL
GILA
YAVAPAI
MOHAVE
COCONINO
NAVAJO
APACHE
GREENLEE
GRAHAM
SANTA CRUZ
COCHISE
PIMA
LUNA
DONA ANA
OTERO
CHAVES
EDDY
LEA
ROOSEVELT
CURRY
QUAY
HARDING
SAN MIGUEL
MONTROSE
OURAY
SAN JUAN
DOLORES
MINERAL
HINSDALE
RIO GRANDE
ALAMOSA
COSTILLA
SAGUACHE
CHAFFEE
LAKE
PARK
TELLER
EL PASO
PUEBLO
CROWLEY
OTERO
KIOWA
BENT
PROWERS
BACA
LINCOLN
CHEYENNE
KIT CARSON
YUMA
PHILLIPS
SEDGWICK
LOGAN
WASHINGTON
MORGAN
ADAMS
ARAPAHOE
KIOWA
CHEYENNE
KIT CARSON
LINCOLN
ELBERT
EL PASO
PUEBLO
CROWLEY
OTERO
KIOWA
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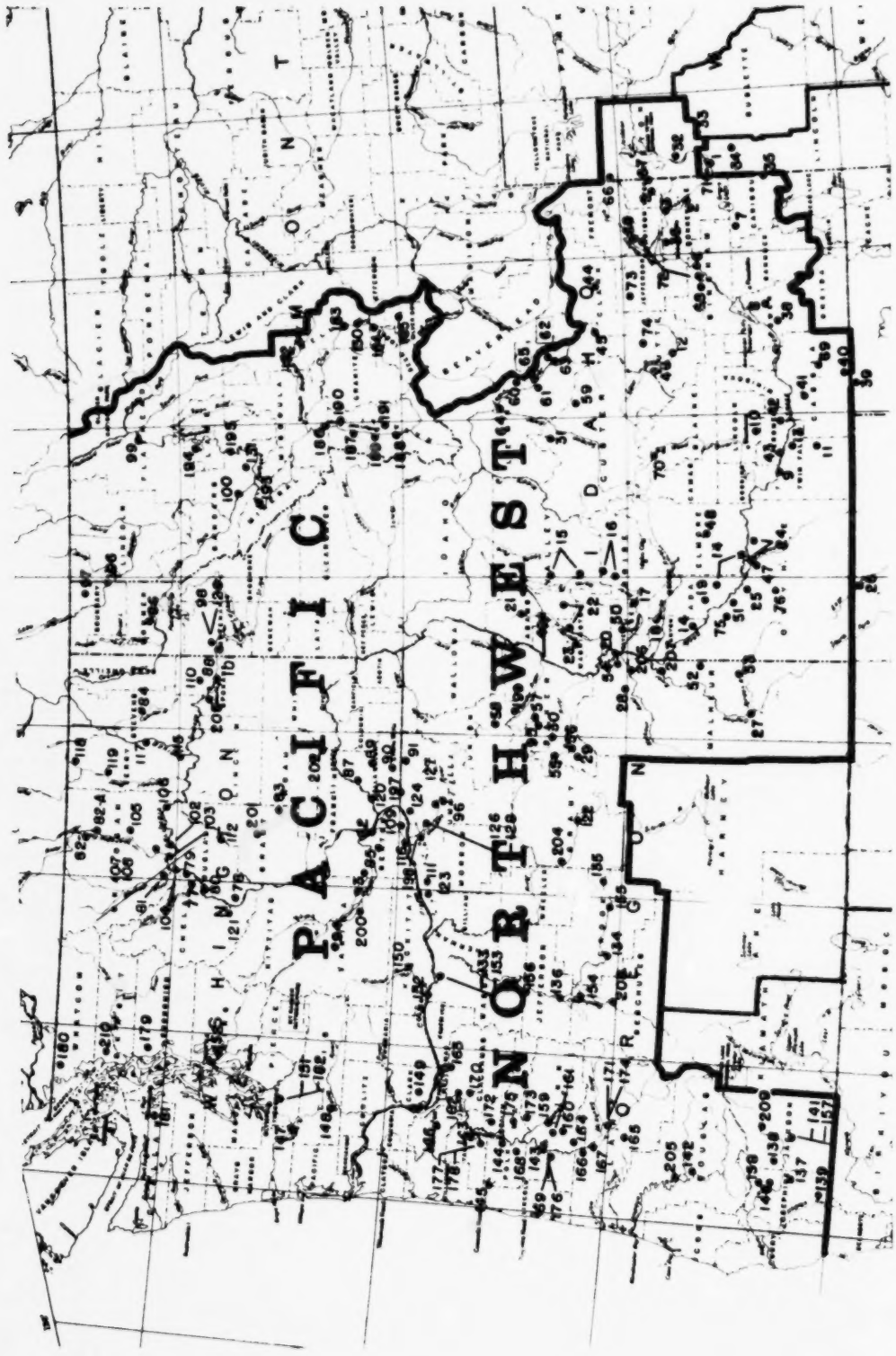
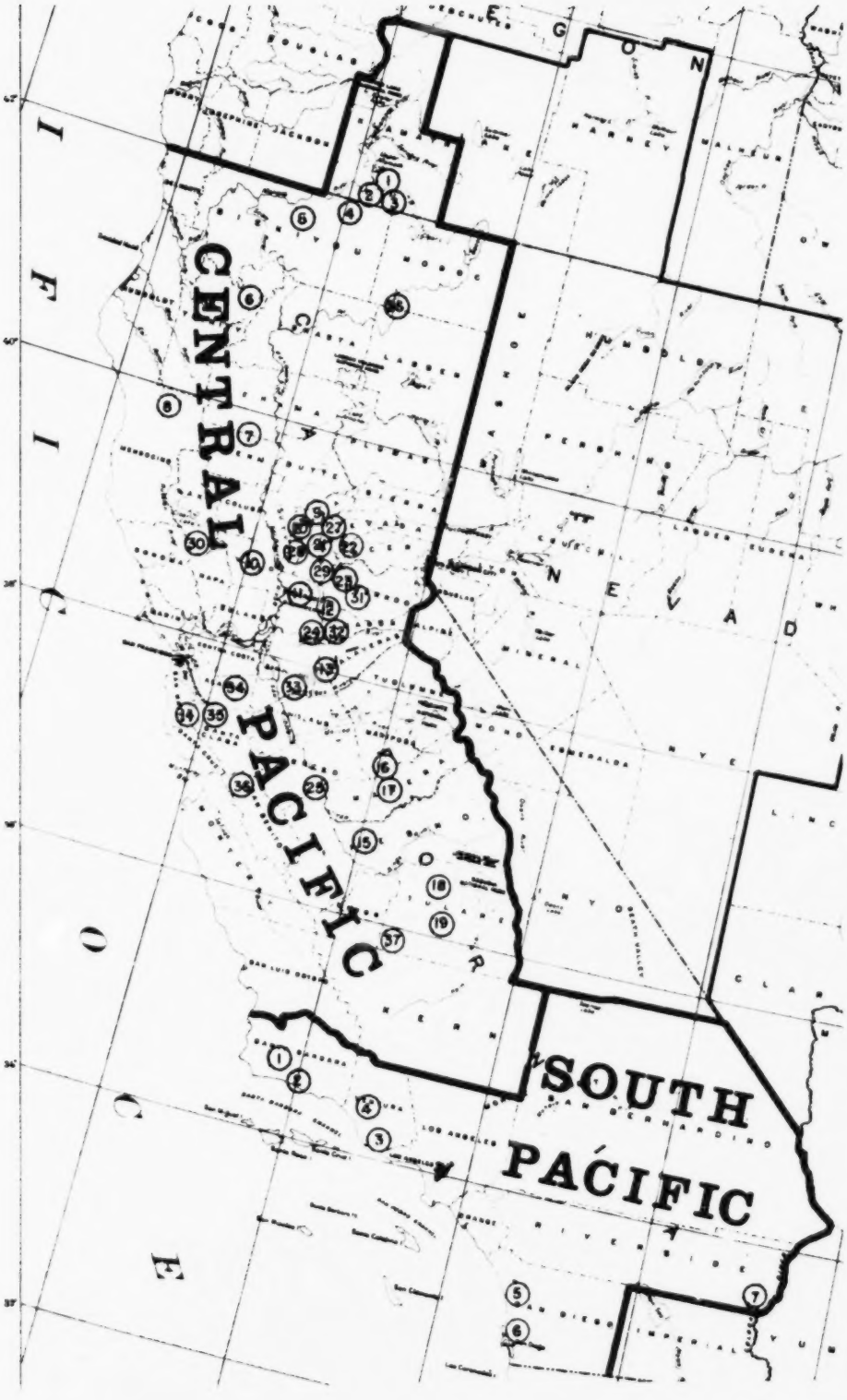
BACA
CUSTER
HUERFANO
LAS ANIMAS
BACA
PARMER
CASTRO
DEAF SMITH
OLDHAM
RANDALL
POTTER
CARSON
ARMSTRONG
DONLEY
COLLINGSWORTH
GRAY
WHEELER
HEMPHILL
ROBERTS
HUTCHINSON
MOORE
HARTLEY
OCHILTREE
LIPSCOMB
SHERMAN
HANSFORD
HOCKLEY
LUBBOCK
LAMB
BAILEY

I D A H O
E G O N
N E V A D A
GREAT
BASIN



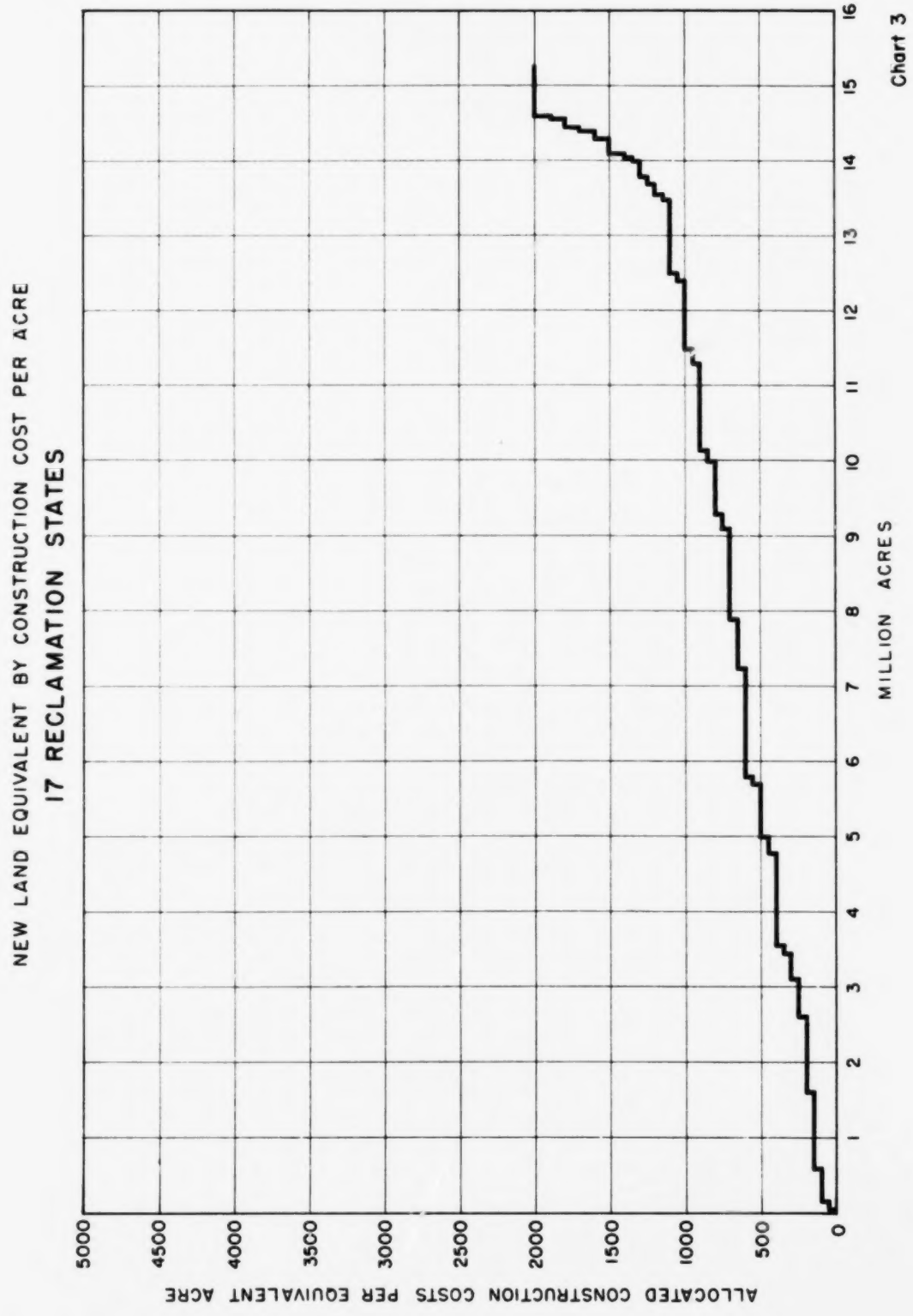
Reproduced from
best available copy.

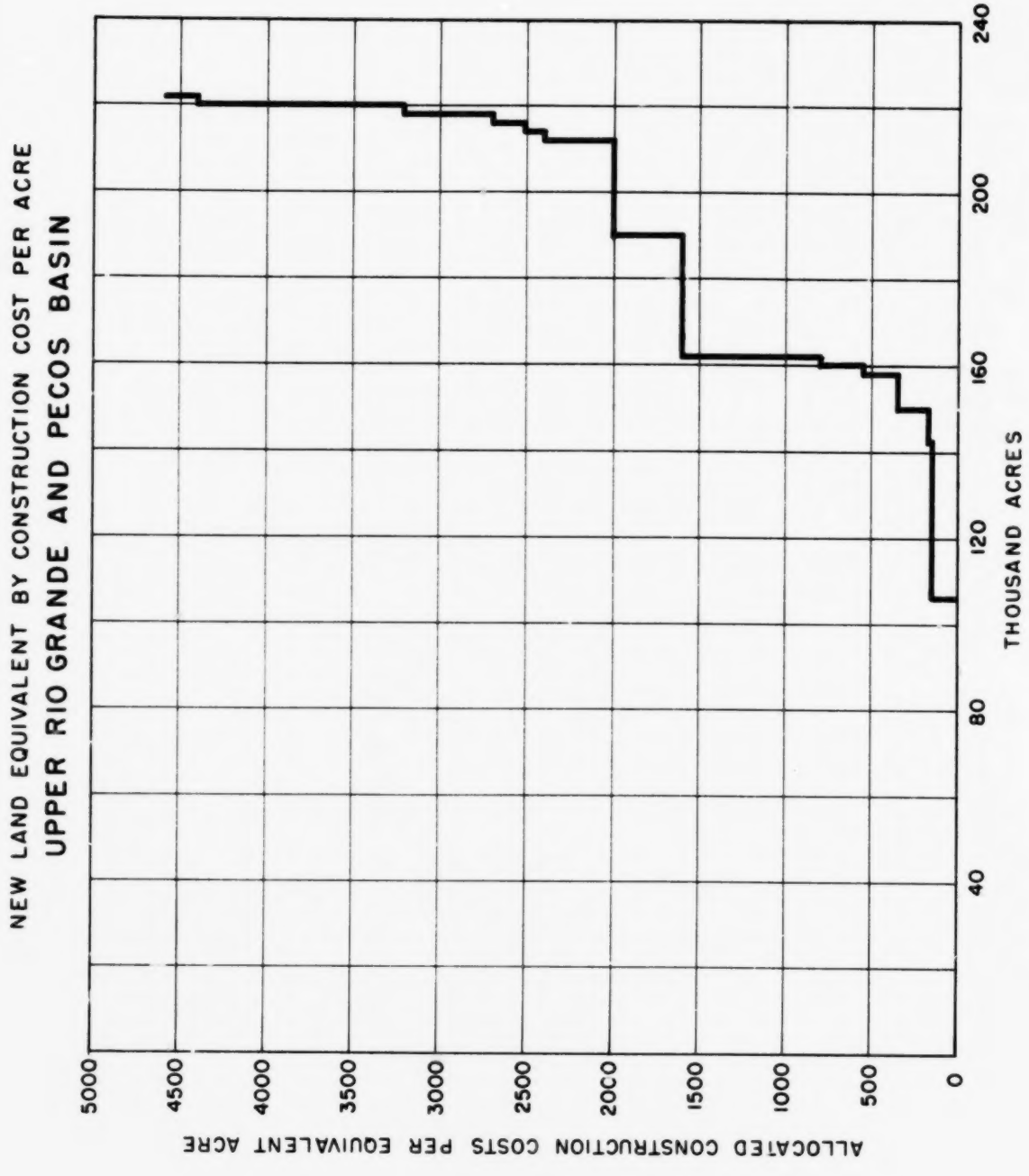

CENTRAL PACIFIC
SOUTH PACIFIC
NEVADA
OREGON

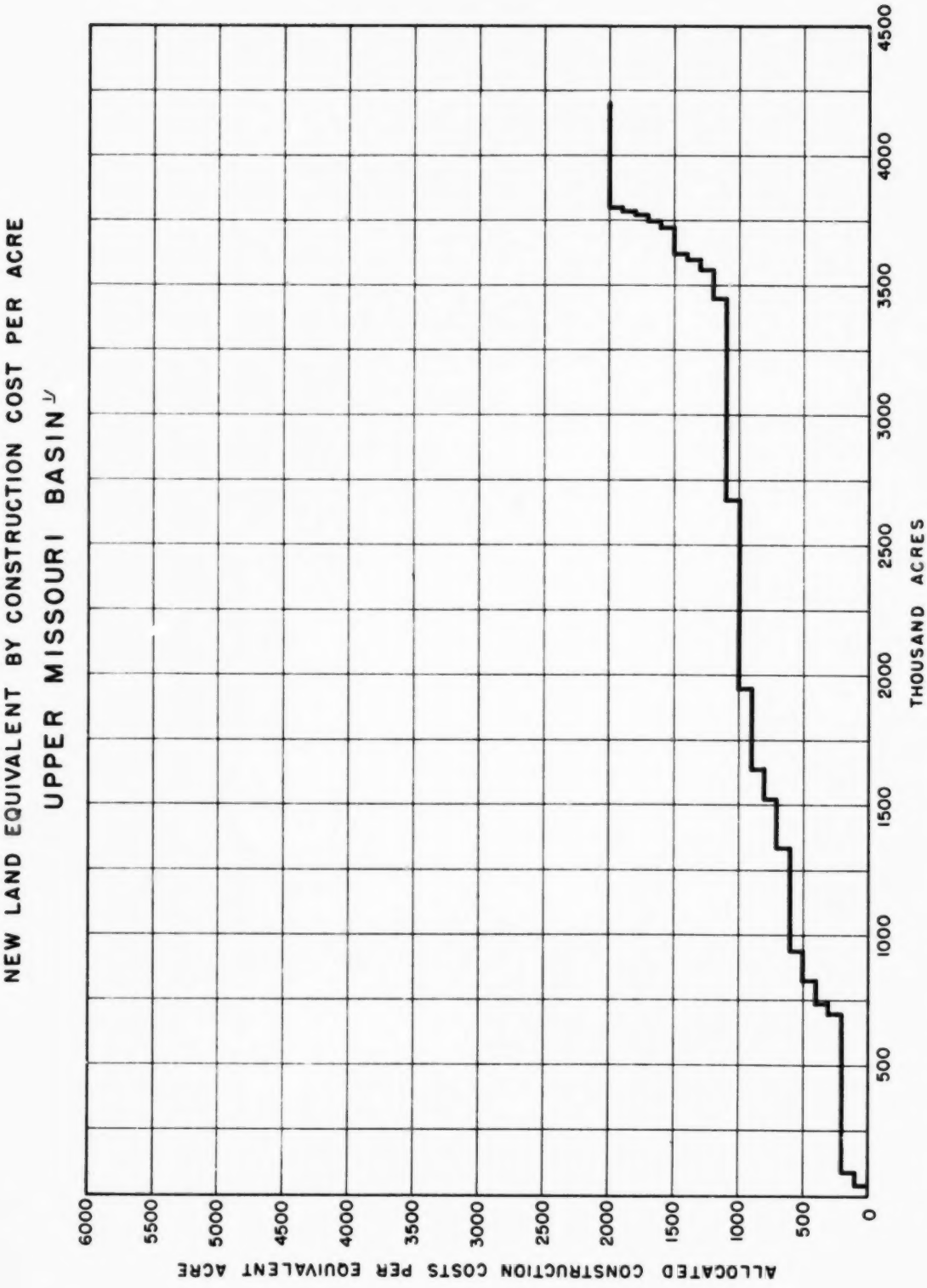
Appendix B

Cost Per Equivalent Irrigated Acre Charts by Water Resource Regions

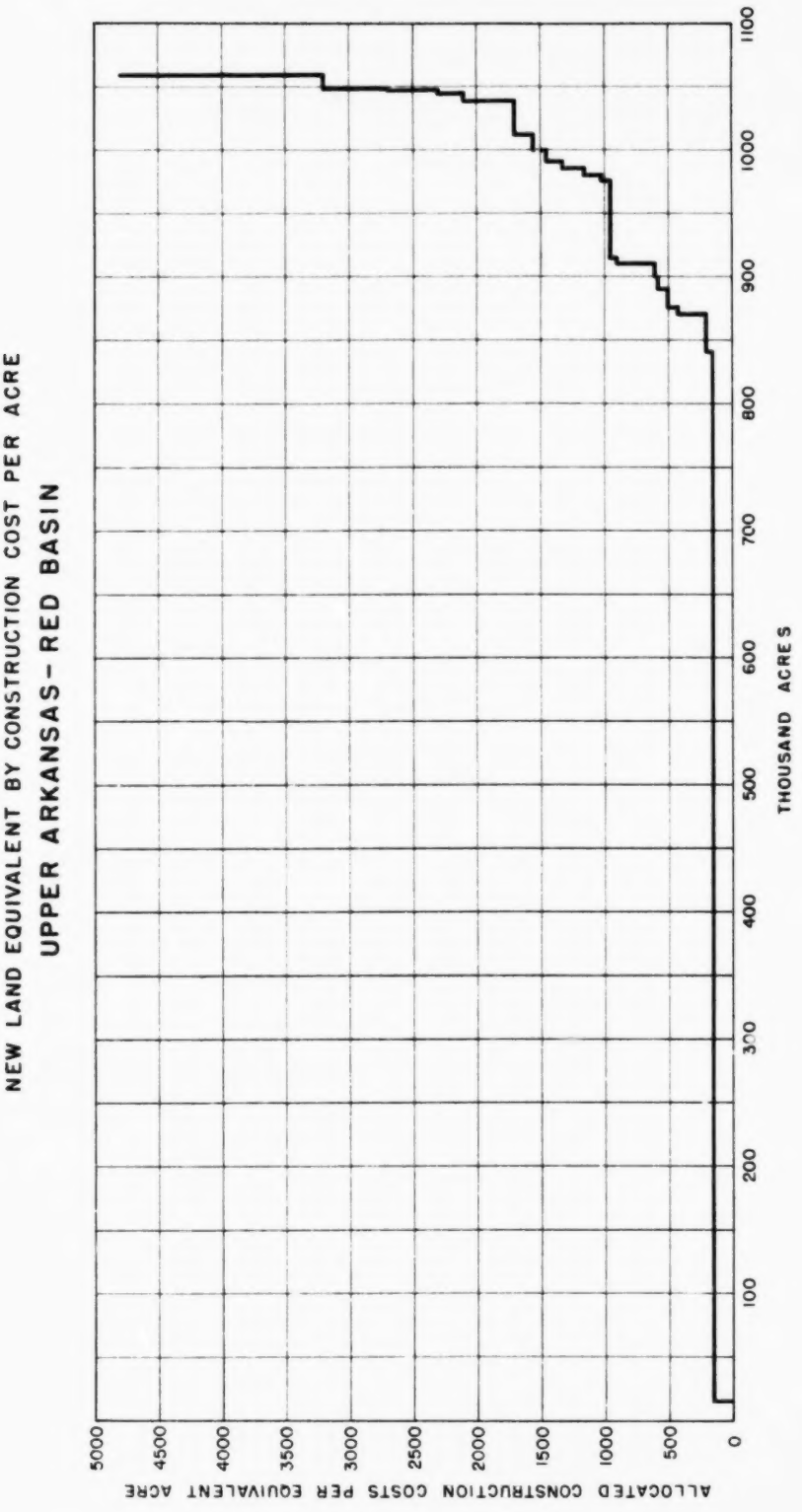
In the upper cost ranges the charts are indicative only and not of the same accuracy as in the cost ranges below $1,000 per acre

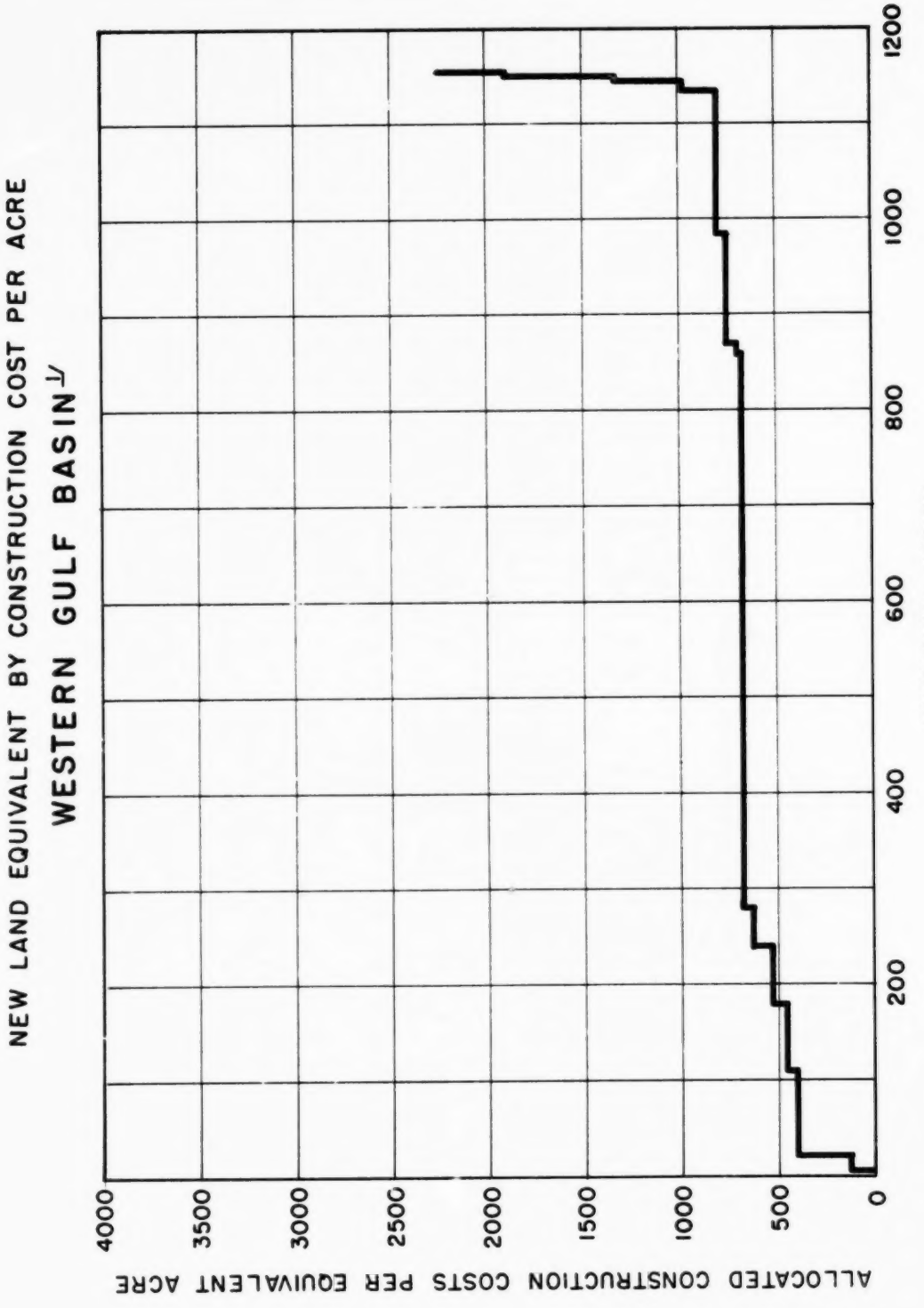



NEW LAND EQUIVALENT BY CONSTRUCTION COST PER ACRE
UPPER RIO GRANDE AND PECOS BASIN
ALLOCATED CONSTRUCTION COSTS PER EQUIVALENT ACRE
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
40
80
120
160
200
240
THOUSAND ACRES



1/ Includes allocated storage cost from Corps of Engineers projects.

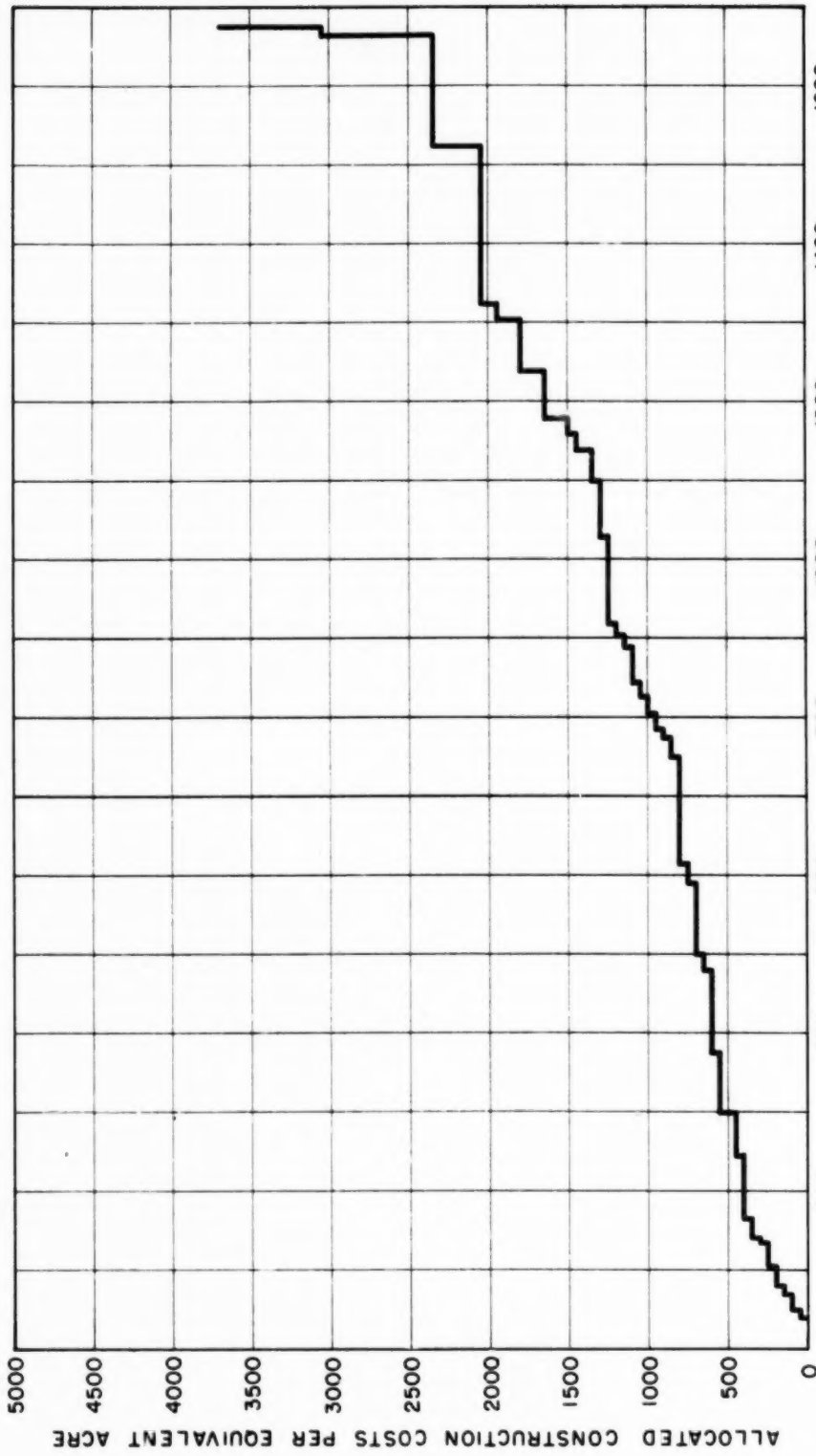

NEW LAND EQUIVALENT BY CONSTRUCTION COST PER ACRE
UPPER ARKANSAS - RED BASIN
ALLOCATED CONSTRUCTION COSTS PER EQUIVALENT ACRE
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
100
200
300
400
500
600
700
800
900
1000
1100
THOUSAND ACRES



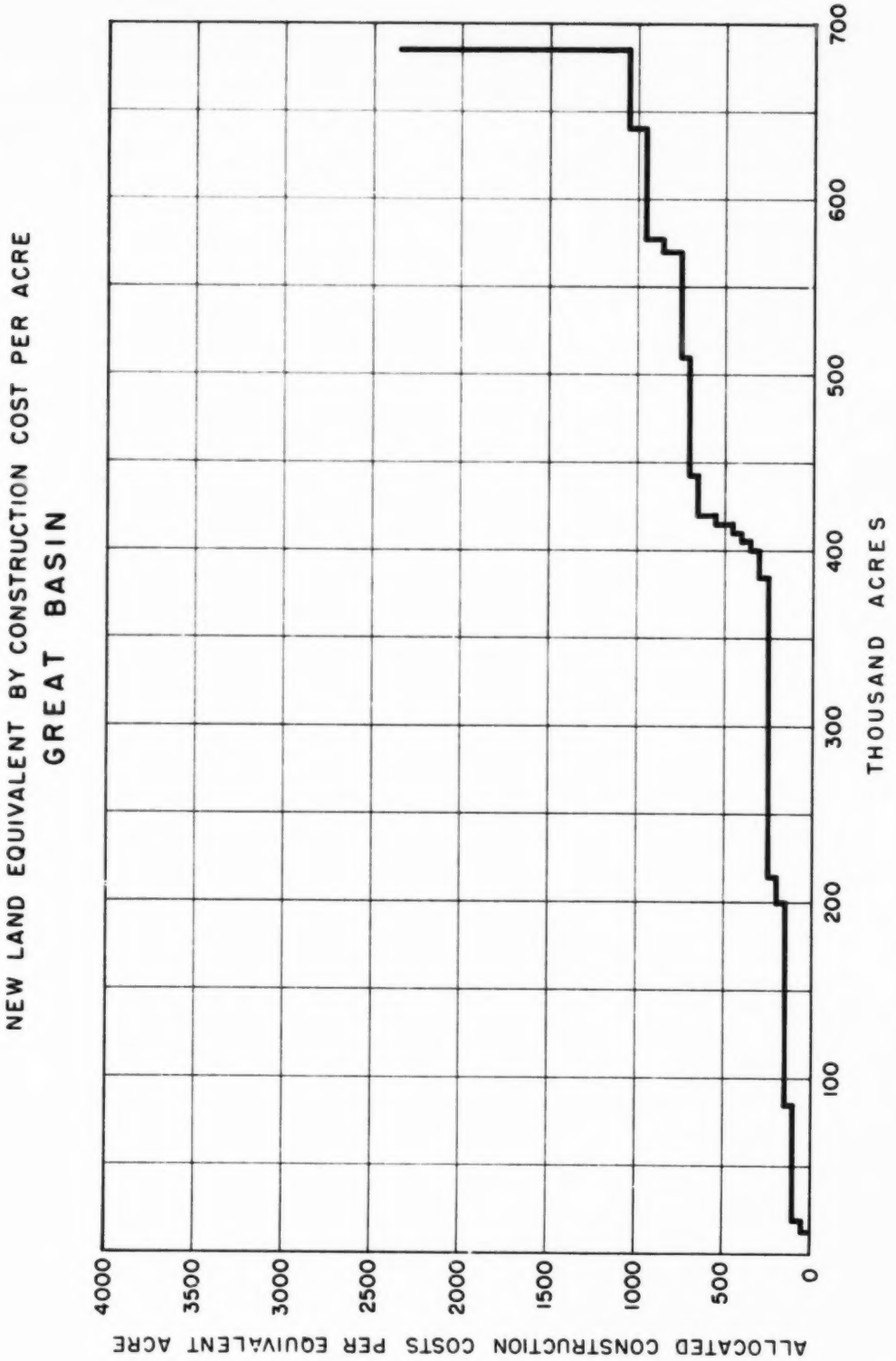
1/Excludes unallocated storage cost from 17 projects

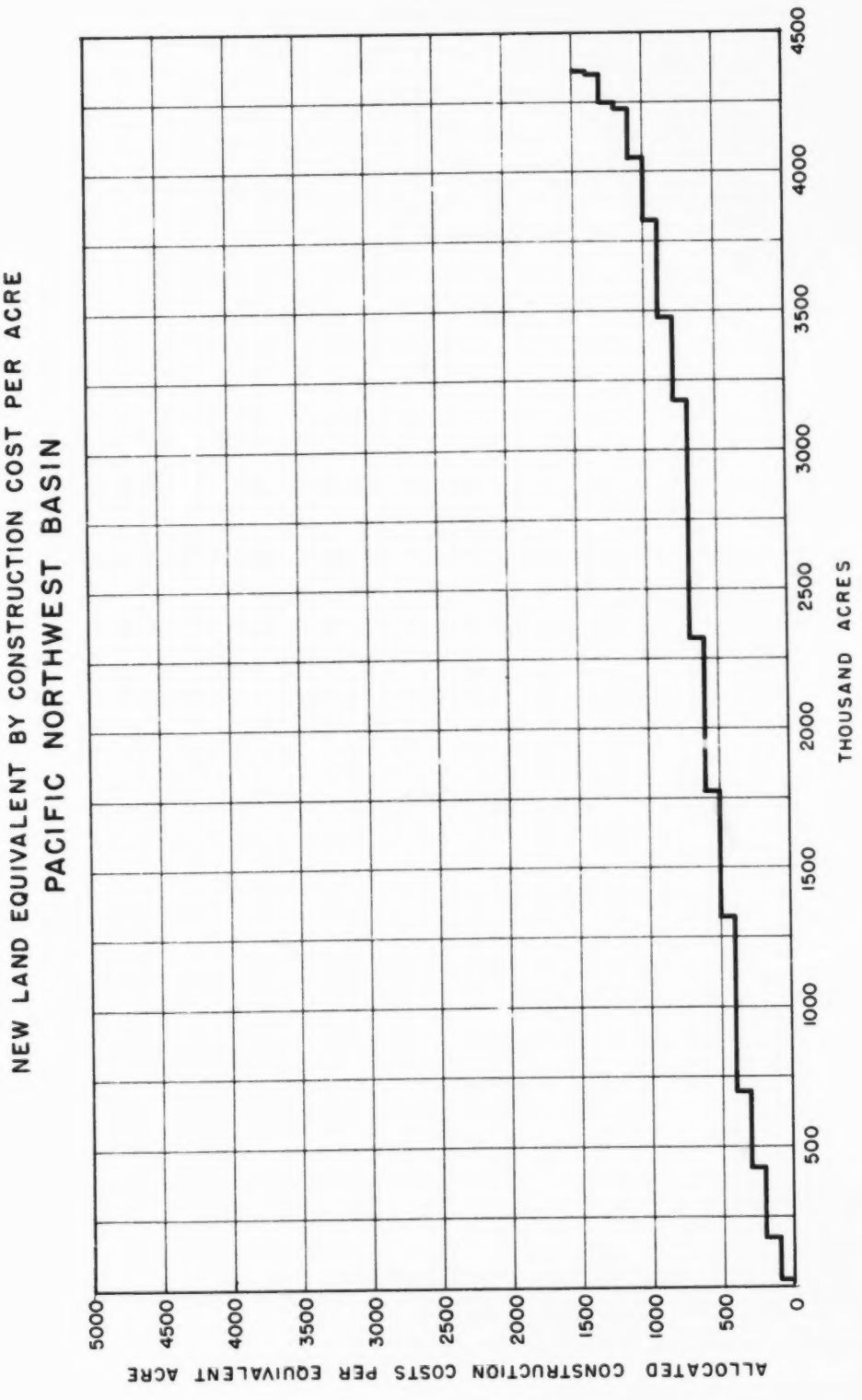
NEW LAND EQUIVALENT BY CONSTRUCTION COST PER ACRE

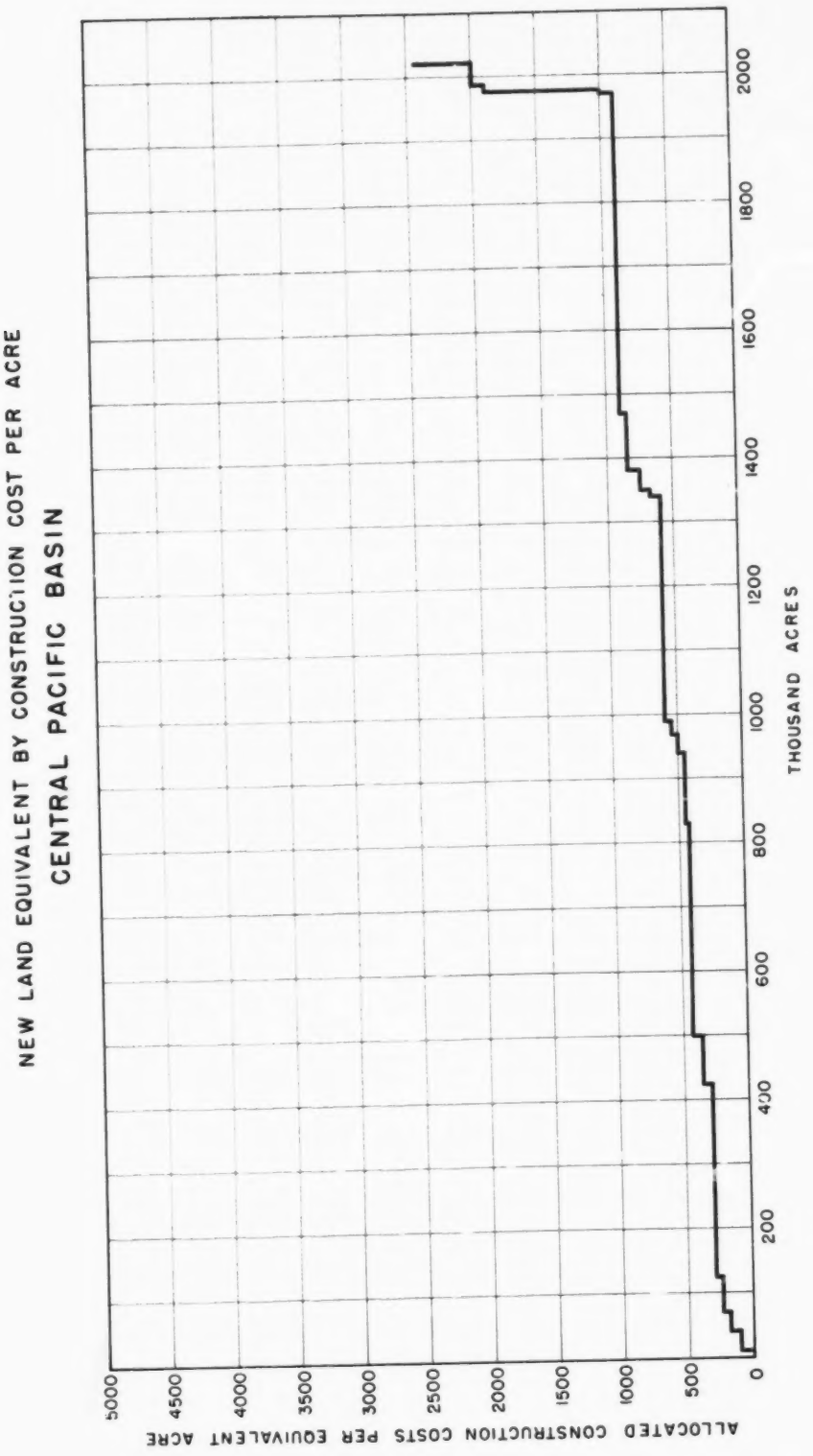
COLORADO BASIN[1/]



[1/]Except Glen Canyon, Cureconti and Flaming Gorge


NEW LAND EQUIVALENT BY CONSTRUCTION COST PER ACRE
GREAT BASIN
ALLOCATED CONSTRUCTION COSTS PER EQUIVALENT ACRE
4000
3500
3000
2500
2000
1500
1000
500
0
100
200
300
400
500
600
700
THOUSAND ACRES


NEW LAND EQUIVALENT BY CONSTRUCTION COST PER ACRE
PACIFIC NORTHWEST BASIN
ALLOCATED CONSTRUCTION COSTS PER EQUIVALENT ACRE
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
500
1000
1500
2000
2500
3000
3500
4000
4500
THOUSAND ACRES


NEW LAND EQUIVALENT BY CONSTRUCTION COST PER ACRE
CENTRAL PACIFIC BASIN
ALLOCATED CONSTRUCTION COSTS PER EQUIVALENT ACRE
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
200
400
600
800
1000
1200
1400
1600
1800
2000
THOUSAND ACRES

Appendix C

U.S. Department of the Interior, Bureau of Reclamation

Total appropriations and allotments to reclamation projects and activities, by States by 10-year intervals

State or State combination	1902–09	1910–19	1920–29	1930–39	1940–49	1950–59	Total
Alaska					$150,000.00	$32,500,420.90	$32,650,420.90
Arizona	$7,325,000.00	$8,253,850.28	$241,851.45	$13,124,000.00	11,270,772.82	51,914,715.31	92,157,189.86
Arizona-California	3,500,000.00	7,814,903.82	4,719,862.77	1,695,700.00	943,501.95	6,256,478.47	24,930,447.01
Arizona-Nevada-California			929,476.09	157,363,000.00	199,731,877.03	199,878,088.76	557,902,941.79
Arizona-Utah						83,842,743.00	83,842,743.00
California	558,000.00	660,221.38	2,021,103.90	34,993,700.00	243,386,525.74	460,744,605.22	742,364,156.24
Colorado	4,140,000.00	7,763,616.94	4,288,736.03	7,892,000.00	85,114,016.75	102,646,654.16	211,945,023.88
Colorado-Kansas					2,500,000.00	10,849,246.97	13,349,246.97
Colorado-New Mexico						10,593,150.00	10,593,150.00
Hawaii				50,000.00		60,000.00	110,000.00
Idaho		713,735.52	1,619,918.45		3,059,845.94	6,835,599.70	12,229,099.12
Idaho-Oregon	2,620,000.00	13,083,433.08	8,609,827.20	6,124,400.00	41,817,798.51	10,251,018.97	82,506,477.76
Idaho-Wyoming	2,516,000.00	6,255,198.23	12,245,420.86	6,971,353.43	7,388,677.43	74,389,243.32	109,765,893.27
Kansas	385,000.00	16,008.89			2,959,213.59	44,489,899.49	47,850,121.97
Montana	2,187,000.00	17,262,835.05	6,279,392.99	7,717,261.77	30,224,575.65	147,508,918.43	211,179,983.89
Montana-North Dakota	2,680,000.00	998,597.68	1,417,971.59	198,500.00	6,976,549.75	16,249,221.46	28,520,840.48
Nebraska					19,669,282.32	58,412,780.14	78,082,262.46
Nebraska-Kansas					2,284,575.98	33,882,609.83	36,167,185.81
Nevada				1,210,000.00	100,000.00	810,909.00	2,120,909.00
Nevada-California	4,098,000.00	4,265,262.00	5,522,040.00	1,080,000.00	[1] −16.38	800,000.00	15,765,285.62
New Mexico	1,033,000.00	1,153,963.14	1,635,949.88	5,185,000.00	12,612,000.00	35,521,701.43	57,141,614.45
New Mexico-Texas	1,285,000.00	9,472,451.32	9,621,020.46	6,873,628.23	5,453,078.67	10,551,478.27	43,256,656.95
North Dakota	935,000.00	490,913.18	665,466.16		7,333,930.43	9,049,968.09	18,475,277.86
Oklahoma	12,000.00	248,000.00		55,000.00	11,479,610.00	12,632,906.21	24,427,516.21
Oregon	1,241,000.00	1,909,335.28	8,867,680.63	3,838,751.15	10,147,295.23	26,195,840.25	52,199,902.54
Oregon-California	2,109,000.00	1,919,455.78	4,939,603.58	1,816,750.61	6,964,005.00	5,808,025.46	23,556,840.43
Oregon-Idaho			4,316,654.84	15,691,800.00	3,080,056.75	1,571,050.00	24,659,561.59
South Dakota	2,350,000.00	2,164,135.70	1,878,235.75	780,716.26	14,577,651.13	22,339,105.45	44,089,844.29
Texas				13,280,000.00	13,653,381.43	4,877,567.50	31,810,948.93
Utah	810,000.00	3,359,392.01	3,608,190.98	11,600,000.00	16,157,349.95	60,028,705.99	95,563,638.93
Utah-Wyoming						16,328,335.00	16,328,335.00
Washington	3,539,000.00	11,036,744.18	16,153,395.51	109,527,188.00	225,680,508.40	297,936,797.44	663,873,633.53
Wyoming		2,469.39	4,542,121.15	19,370,959.46	46,030,724.64	110,922,768.69	180,869,043.33
Wyoming-Montana	3,477,000.00	3,276,849.74	5,876,236.22	4,137,943.93	10,695,418.87	9,970,763.18	37,434,211.94
Wyoming-Nebraska	4,230,000.00	7,976,682.91	12,424,541.64	877,286.38	1,860,070.96	5,989,129.55	33,357,711.44
Colorado River storage and participating project advance planning and transmission						3,950,107.00	3,950,107.00
Missouri River Basin investigations, operations and maintenance, and transmission					26,919,048.82	198,359,982.77	225,279,031.59
General investigations and administration	983,104.61	4,249,750.11	1,543,399.72	9,614,153.65	54,633,293.66	100,140,901.18	171,164,602.93
Total	52,013,104.61	114,347,805.12	123,968,597.76	441,169,092.87	1,124,854,621.02	2,285,118,636.59	4,141,471,857.97

[1] Transfer of lapsed emergency relief funds.

Future Needs for Reclamation In the Western States

Appendix D. List of Names of Potential Projects

UPPER MISSOURI RIVER BASIN

[Map p. 28]

No.[1]	Name of potential project	River
1	Shoshone extension	Shoshone.
2	Yellowtail-Hardin	Bighorn.
3	Bighorn	Do.
4	Greybull Flat	Do.
5	Benteen Flat	Little Bighorn.
6	Little Bighorn	Do.
7	Kaycee	Powder.
8	Piney	Clear Creek.
9	Crowheart	Wind.
10	Du Noir	Do.
11	Hudson Bench	Do.
12	Huntley No. 2	Yellowstone.
13	Huntley No. 3	Do.
14	Sadie Flat	Do.
15	Seven Mile Flat	Do.
16	Stipek	Do.
17	Shoshone Extension Addition	Shoshone.
18	Shoshone Extension	Do.
19	Battlefield	Little Bighorn.
20	Crow	Do.
21	Dunmore	Do.
22	Wyola	Do.
23	Buffalo	Clear Creek.
24	Crazy Woman	Crazy Woman Creek.
25	French Creek	Clear Creek.
26	Lower Powder	Powder.
27	Moorhead	Do.
28	Ucross	Clear Creek.
29	Sheridan	Tongue.
30	Tongue Pumping	Do.
31	Little Wind	Wind.
32	Shoshoni	Bighorn.
33	Abbey	Yellowstone.
34	Absaroka	Do.
35	Cartwright	Do.
36	Cove No. 1	Do.
37	Cove No. 2	Do.
38	Cracker Box	Do.
39	Elm Coulee	Do.
40	Forsyth	Do.
41	Fort Keogh	Do.
42	Haley	Do.
43	Hathaway	Do.

[1] Corresponding to number on map.

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UPPER MISSOURI RIVER BASIN—Continued

[Map p. 28]

No.[1]	Name of potential project	River
44	Marsh	Yellowstone.
45	Orinoco	Do.
46	Saugus-Calypso	Do.
47	Seven Sisters	Do.
48	Sidney	Do.
49	Sitting Bull	Do.
50	Antelope	Do.
51	Chimney Rock	Do.
52	Colgate	Do.
53	Greycliff	Do.
54	Badwater	Bighorn.
55	Whitehorse Bench	Clarks Fork, Yellowstone.
56	Badger Basin	Do.
57	Popo Agie	Wind.
58	Tipperary	Do.
59	Paintrock	Bighorn.
60	Rosebud	Yellowstone.
61	Sweetgrass	Do.
62	Chapman Bench	Clarks Fork, Yellowstone.
63	Lower Marias	Marias.
64	East Bench	Beaverhead.
65	Missouri Diversion	Missouri.
66	N Bar N	Do.
67	Nickwall	Do.
68	Yellow Bluff	Do.
69	Jefferson	Big Hole.
70	West Bench	Birch Creek.
71	Whitehall	Big Hole.
72	Chestnut Valley	Missouri.
73	Newlan	Smith.
74	Rock Creek	Rock Creek.
75	Hobson	Judith.
76	Lewistown	Spring Creek.
77	Ross Fork	Ross Fork.
78	Glasgow Bench	Missouri.
79	Saco Divide	Milk.
80	Bonanza	Missouri.
81	Brush	Do.
82	Diamond Ranch	Do.
83	Farmer Creek	Do.
84	Hardscrabble	Do.
85	Medicine Lake North	Do.
86	Medicine Lake South	Do.
87	Nohle	Do.
88	Shoestring	Do.
89	Shotgun	Do.
90	Sun-Teton	Sun and Teton.
91	Cameron Bench	Madison.
92	Clarkston	Missouri.
93	Gallatin	Gallatin.
94	Madison	Madison.
95	Blacktail	Blacktail Deer Creek.
96	Boulder	Boulder.
97	Charley Creek	Missouri.

[1] Corresponding to number on map.

UPPER MISSOURI RIVER BASIN—Continued

[Map p. 28]

No.[1]	Name of potential project	River
98	Cottonwood	Cottonwood Creek.
99	Horse Prairie	Horse Prairie.
100	Stanford	Wolf Creek.
101	Ashfield	Beaver Creek.
102	Heart Butte	Heart.
103	Garrison	Missouri.
104	Bismarck	Do.
105	Hancock Flats	Do.
106	Oliver-Sanger	Do.
107	Williston	Do.
108	Garrison	Do.
109	Broncho	Knife.
110	Alzada	Little Missouri.
111	Burnt Creek	Missouri.
112	Horsehead Flats	Do.
113	Manley	Do.
114	Nesson	Do.
115	Painted Woods	Do.
116	Square Butte	Do.
117	Winona	Do.
118	Wogansport	Do.
119	Cannonball	Cannonball.
120	Little Heart	Missouri.
121	Thunderhawk	Cedar Creek.
122	Mott	Cannonball.
123	Garrison extension	Missouri.
124	Fort Yates	Do.
125	Shadehill	Grand.
126	Oahe	Missouri.
127	Greenwood	Do.
128	Tower	Do.
129	Yankton	Do.
130	Crazy Horse	Do.
131	Wagner	Do.
132	Culdesac	Do.
133	La Roche	Do.
134	Rousseau	Do.
135	Geddes	Do.
136	Tyndall	Do.
137	Oahe	Do.
138	Rapid Valley	Rapid Creek.
139	Belle Fourche pumping	Belle Fourche.
140	Edgemont	Beaver Creek.
141	Fort Thompson	Missouri.
142	Grass Rope	Do.
143	Iron Nation	Do.
144	Joe Creek	Do.
145	Fort Hale	Do.
146	Evarts	Do.
147	Mobridge	Do.
148	Pollock-Herreid	Do.
149	Pine Ridge	White.
150	Cheyenne pumping	Cheyenne.
151	Philip	Bad.

[1] Corresponding to number on map.

UPPER MISSOURI RIVER BASIN—Continued

[Map p. 28]

No.[1]	Name of potential project	River
152	Bowman-Haley	Grand.
153	Big Sheep Creek	Big Sheep Creek.
154	North Chinook	Lodge Creek.
155	Clear Creek	Clear Creek.
156	Five Mile Creek	Five Mile Creek.
157	Rosebud River storage	Rosebud.
158	Little Beaver Creek	Little Beaver Creek.
159	Box Elder storage	Box Elder Creek.
160	Fort Benton pumping	Missouri.
161	Prickly Pear Creek	Prickly Pear Creek.
162	Canyon Creek	Canyon Creek.
163	Bell Lake	Bell Lake.
164	Dorsey	Musselshell.
165	Benton Creek	Benton Creek.
166	North Side Canal	Musselshell.
167	Four Mile Creek	Four Mile Creek.
168	Benson Dam	Musselshell.
169	Mill Creek storage	Mill Creek.
170	McGinnis Creek	McGinnis Creek.
171	Rosebud Creek storage	Rosebud Creek.
172	Miller Creek Canal	Miller Creek.
173	Shaffner Creek	Shaffner Creek.
174	Groundwater pumping	
175	Oahe extensions	Missouri.
176	Gooseberry Valley	Clarks Fork, Yellowstone.
177	Grass Creek Basin	Do.
178	Wagon Hound Bench	Do.
179	Putney Flat	Do.
180	Wheatland unit	Laramie.
181	Glendo inundated water rights	North Platte.
182	Kendrick unit No. 2	Do.
183	Water conservation unit	Do.
184	Ainsworth unit	Snake.
185	Lavaca Flats unit	Niobrara.
186	O'Neill unit	Do.
187	Springview unit	Do.
188	Mirage Flats extension unit	Do.
189	Ponca Creek unit	Ponca Creek.
190	Boiling Springs unit	Niobrara.
191	Verdigre unit	Do.
192	Keya Paha unit	Keya Paha.
193	Page unit	Niobrara-Offstream.
194	Cedar Rapids division	Cedar, Loup.
195	Farwell unit	Middle Loup.
196	North Loup division	Calamus, North Loup, Loup.
197	Sargent unit	Middle Loup.
198	Albion unit	Beaver Creek.
199	Mid-State	Platte.
200	St. Francis unit	South Fork, Republican.
201	North Republican unit	North Fork, Republican.
202	Benkelman unit	Republican.
203	Frenchman-Cambridge division	Do.
204	Nelson Buck unit	Beaver Creek.
205	Oberlin unit	Sappa Creek.

[1] Corresponding to number on map.

UPPER MISSOURI RIVER BASIN—Continued

[Map p. 28]

No.[1]	Name of potential project	River
206	Almena unit	Prairie Dog Creek.
207	Bostwick division	Republican.
208	Concordia unit	Do.
209	Clay Center unit	Do.
210	Webster unit	South Fork, Solomon.
211	Glen Elder unit	Solomon.
212	Cedar Bluff unit	Smoky Hill.
213	Ellis unit	Big Creek.
214	Wilson unit	Saline.
215	Kanopolis unit	Smoky Hill.
216	Kipp unit	Do.
217	Abilene unit	Turkey Creek.
218	Chapman unit	Chapman Creek.
219	Little Blue unit	Little Blue.
220	Wamego unit	Rock Creek.
221	Bellvue unit	Vermillion Creek.
222	Rossville unit	Kansas.
223	Menaken unit	Soldier Creek.
224	Grantville unit	Kansas.
225	Perry unit	Do.
226	Lawrence unit	Wakarusa.
227	Narrows unit	South Platte.
228	Cache La Poudre unit	Cache La Poudre.
229	Groundwater pumping (Wyoming-Nebraska)	North Platte tributaries.
230	Naper unit	Niobrara.
231	Valentine unit	Minnechaduza Creek.
232	Bonesteel unit	Missouri.
233	Lees Park unit	Middle Loup.
234	Columbus division	Loup.
235	Elkhorn division	Elkhorn.
236	Plattehorn division	Platte, Elkhorn.
237	Wynot-Crofton	Missouri.
238	Talmadge unit	Little Nemaha.
239	Dawson unit	North Fork, Big Nemaha.
240	Verdon unit	Muddy Creek.
241	Hiawatha unit	Walnut Creek.
242	Seneca unit	South Fork, Big Nemaha.
243	Sterling unit	North Fork, Big Nemaha.
244	Wilber unit	Big Blue.
245	Sedgwick unit	South Platte.
246	Julesburg unit	Do.
247	Rowell Hill unit	St. Vrain Creek, South Platte.
248	Empire Reservoir unit	Clear Creek, South Platte.
249	Wattenburg unit	Big Dry Creek, South Platte.
250	Bald Mountain unit	Bear Creek, South Platte.
251	Denver municipal return flow	South Platte.
252	Pumping from ground water	Niobrara.
253	Pumping from Niobrara River or its tributaries	Do.
254	Tricounty division	Lower Platte.
255	North Loup River Public Power and Irrigation District	North Loup.
256	Middle Loup Public Power and Irrigation District	Middle Loup.
257	Private development (wells and stream pumps)	Lower Platte.
258	Republican River Basin	Republican.
259	Smoky Hill River Basin	Smoky Hill.

[1] Corresponding to number on map.

UPPER MISSOURI RIVER BASIN—Continued

[Map p. 28]

No.[1]	Name of potential project	River
260	Blue River Basin	Blue.
261	Missouri River Valley area	Northeast Kansas, Missouri.
262	Pumping from ground water	Niobrara.
263	Pumping from Niobrara River or its tributaries	Do.
264	Private development (wells and stream pumps)	Lower Platte.
265	Missouri River Valley area	Northeast Kansas, Missouri.

UPPER RIO GRANDE AND PECOS RIVER BASIN

[Map p. 27]

1	Barranca	Rio Chama.
2	El Rito	El Rito Creek.
3	Embudo Creek	Embudo Creek.
4	Ensenada	Rio Chama and tributaries.
5	Ojo Caliente	Caliente River.
6	Mimbres	Mimbres River.
7	Tularosa	Tularosa River.
8	San Juan-Chama	San Juan River.
9W	Wagon Wheel Gap, San Luis Valley	Rio Grande.
9C	Closed Basin, San Luis Valley	Do.
10	San Jose-Villanueva	Pecos River.
11	Brantley Reservoir	Do.
12	Hooker Dam	Gila River.
13	Santa Clara	Rio Chama.
14	Jemez	Jemez Creek.
15	Cuba	Rio Puerco.
16	Tome Flats	Rio Grande.
17	Isleta Flats	Do.

UPPER ARKANSAS-RED RIVERS BASIN

[Map p. 29]

1	Cheney Reservoir, Wichita project	North Fork, Ninnescah River.
2	Murdock Reservoir, Wichita project	South Fork, Ninnescah River.
3	Augusta Reservoir	Whitewater River.
4	Silverdale Reservoir	Silver Creek.
5	Chikaskia project	Chikaskia River.
6	Canton irrigation project	North Canadian River.
7	Union project	Canadian River.
8	Canadian River project	Do.
9	Norman project	Little River.
10	Waurika project	Beaver Creek.
11	Ringgold Reservoir	Little Wichita River.
12	Mangum project	Salt Fork.
13	Mountain Park	Otter Creek.
14	Washita Basin project (irrigation)	Washita River.
15	Arbuckle project	Rock Creek.
16	Ute Dam and Reservoir	Canadian River.
17	Halstead Reservoir	Little Arkansas River.
18	Newton Reservoir	Do.

[1] Corresponding to number on map.

UPPER ARKANSAS-RED RIVERS BASIN--Continued

[Map p. 29]

No.[1]	Name of potential project	River
19	Conway Springs Reservoir	Slate Creek.
20	El Dorado Reservoir	Walnut River.
21	Douglas Reservoir	Little Walnut River.
22	Wingate	Rock Creek.
23	Kiowa project	Medicine Lodge River.
24	Caldwell project	Bluff Creek.
25	Beaver Reservoir	Beaver Creek.
26	Red Rock Reservoir	Red Rock Creek.
27	Shidler Reservoir	Salt Creek.
28	Englewood project	Cimarron River.
29	Crescent Reservoir	Do.
30	Seward Reservoir	Cottonwood Creek.
31	Welty Reservoir	Deep Fork.
32	Bristow Reservoir	Little Deep Fork.
33	Black Mesa	Cimarron River.
34	Cimarron Creek	Cimarron Creek.
35	Miami	Rayado Creek.
36	Mora	Mora River.
37	Vermejo (ultimate)	Vermejo River.
38	Thomas Reservoir	Deer Creek.
39	Boggy Reservoir	Boggy Creek.
40	Purcell Reservoir	Walnut Creek.
41	Pearson Reservoir	Salt Creek.
42	Randlett Reservoir	Deep Red Run.
43	Hennepin Reservoir	Wildhorse Creek.
44	Oklahoma City irrigation project	North Canadian River.
45	Fryingpan-Arkansas	Upper Arkansas River.
46	Trinidad (Corps of Engineers reservoir)	Purgatoire River.
47	Ingalls	Upper Arkansas River.
48	Granada, Syracuse Reservoir (Corps of Engineers)	Do.
49	Arkansas River, channelization	Do.
50	Groundwater development	Do.
51	do	Do.

WESTERN GULF RIVER BASIN

[Map p. 31]

1	Toledo Bend	Sabine River.
2	McGee Bend	Angelina River.
3	Navarro Mills	Richland Creek.
4	Bardwell	Waxahachie Creek.
5	Hightower	Brazos River.
6	Bee Mountain	Do.
7	Lake Waco	Bosque River.
8	Proctor	Leon River.
9	Lampasas	Lampasas River.
10	Lakeport	San Gabriel River.
11	Somerville	Yegua Creek.
12	Ferguson	Navasota River.
13	Irrigation, alluvial lands below Waco	Brazos River.
14	Irrigation (Little River)	Little River.

[1] Corresponding to number on map

WESTERN GULF RIVER BASIN—Continued

[Map p. 31]

No.[1]	Name of potential project	River
15	San Angelo (Twin Buttes Reservoir)	South Concho River.
16	Columbus Bend	Colorado River.
17	San Saba	San Saba River.
18	Irrigation (Brownwood)	Pecan Bayou.
19	Canyon	Guadalupe River.
20	Hochheim	Do.
21	Westhoff	Sandies Creek.
22	Falls City	San Antonio River.
23	Diablo (U.S. share)	Rio Grande.
24	3 channel control dams (lower Rio Grande Valley)	Do.
	Coastal area:	
25	New lands in valley.	
26	Supplemental supply.	
27	Baffin Bay.	
28	Colorado-Brazos Delta.	
29	Iron Bridge	Sabine River.
30	Ponta	Angelina River.
31	Mud Creek	East Mud Creek.
32	Blackburn Crossing	Neches River.
33	Weches	Do.
34	Fossil Creek (Halfom City)	Fossil Creek.
35	Aubrey	Elm Fork, Trinity River.
36	Garza-Little Elm (reallocation)	Do.
37	Roanoke	Denton Creek.
38	Grapevine (reallocation)	Do.
39	Forney	East Fork, Trinity River.
40	Cedar Creek	Cedar Creek.
41	Urbana (Livingstone)	Trinity River.
42	Wallisville (salt water barrier)	Do
43	San Jacinto No. 4 site	West Fork, San Jacinto River.
44	San Jacinto No. 3 site	Do.
45	San Jacinto No. 1 site	Do.
46	Stewart Creek site	Stewart Creek.
47	West Fork No. 0 site	West Fork, San Jacinto River.
48	East San Jacinto No. 1 site	East Fork, San Jacinto River.
49	Hubbard Creek	Hubbard Creek.
50	Champion Creek	Champion Creek.
51	Silver	Colorado River.
52	Irrigation	Guadalupe and San Antonio Rivers.
53	Concan	Frio River.
54	Sabinal	Sabinal River.
55	Wesley Seale enlargement	Nueces River.
56	State Line (with Toledo Bend)	Sabine River.
57	Rockland	Neches River.
58	Liberty (Capers Ridge)	Trinity River.
59	Breckenridge	Clear Fork.
60	LaPryor	Nueces River.
61	Cotulla	Do.
62	Fowlerton	Frio River.
63	Lake Fork	Lake Fork River.
64	Italy	Chambers Creek.
65	Richland Creek	Richland Creek.
66	Tennessee Colony	Trinity River.
67	Irrigation Trinity River Basin	Do.

[1] Corresponding to number on map

WESTERN GULF RIVER BASIN—Continued

[Map p. 31]

No.[1]	Name of potential project	River
68	San Jacinto No. 2 site	West Fork, San Jacinto River.
69	Lake Creek site	Lake Creek.
70	Cypress Creek No. 2 site	Cypress Creek.
71	Peach Creek No. 2 site	Peach Creek.
72	Peach Creek No. 1 site	Do.
73	Caney Creek site	Caney Creek.
74	Allens Creek	Allens Creek.
75	Antelope	Colorado River.
76	Irrigation, Austin to LaGrange	Do.
77	Confluence	Guadalupe River.
78	Whitsett	Atascosa River.

COLORADO RIVER BASIN

[Map p. 32]

1	Eden	Big Sandy Creek.
2	Collbran	Plateau Creek.
3	Paonia	North Fork, Gunnison River.
4	Vernal unit, Central Utah project	Ashley Creek.
5	Curecanti unit, Colorado River storage project	Gunnison River.
6	Flaming Gorge unit, Colorado River storage project	Green River.
7	Glen Canyon unit, Colorado River storage project	Colorado River.
8	Navajo unit, Colorado River storage project	San Juan River.
9	Emery County	Cottonwood Creek.
10	Florida	Florida River.
11	Hammond	San Juan River.
12	LaBarge	Green River.
13	Lyman	Smith Fork and Blacks Fork.
14	Seedskadee	Green River.
15	Silt	Rifle Creek.
16	Smith Fork	Smith Fork, Gunnison River.
17	Animas-La Plata, Teft Reservoir	Animas and La Plata Rivers.
18	Battlement Mesa	Buzzard Creek.
19	Bluestone	Colorado River.
20	Bostwick Park	Cimarron Creek.
21	Dallas Creek	Dallas Creek.
22	Dolores	Dolores River.
23	Dulce	Navajo River.
24	Fontenelle	Fontenelle Creek.
25	Fruitland Mesa	Gunnison River tributary.
26	Grand Mesa	Do.
27	Juniper	Yampa River.
28	Ohio Creek	Ohio Creek.
29	Opal	Hams Fork.
30	Parshall	Williams River.
31	Rabbit Ear	Muddy Creek.
32	San Miguel	San Miguel River.
33	Savery-Pot Hook	Savery Creek and Slater Fork.
34	Sublette, West Side division	Green River.
35	Sublette, Buckskin division	Do.
36	Tomichi Creek	Tomichi and Quartz Creeks.
37	Troublesome	Williams River and Troublesome Creek.

[1] Corresponding to number on map.

COLORADO RIVER BASIN—Continued

[Map p. 32]

No.[1]	Name of potential project	River
38	Wessels	Yampa River.
39	West Divide	Colorado River tributary.
40	Yellow Jacket	Yampa River tributary.
41	Navajo irrigation	San Juan River.
42	Fruitland unit	Do.
43	Hogback extension	Do.
44	Piedra diversions	Piedra River.
45	San Juan diversions	San Juan River.
46	Mancos Wells	
47	Jicarilla	Navajo River.
48	Rock Creek Bottoms	Duchesne River.
49	Little Valley	Do.
50	Wissiup Bottoms	Do.
51	Willow Creek	Willow Creek.
52	White River	White River.
53	Bitter Creek	Do.
54	Burns Creek	Derby and Sunnyside Creeks.
55	Cataract Lake	Black, Cataract, and Elliot Creeks.
56	Cattle Creek	Roaring Fork tributary.
57	Central Utah (ultimate)	Green, Duchesne, Jordan, and Sevier Rivers.
58	Cochetopa Creek	Cochetopa Creek.
59	DeBeque	Colorado River.
60	Eagle Divide	Piney River.
61	Fraser	Fraser River.
62	Gateview	Lake Fork of Gunnison River.
63	Great Northern	Elk River, Fortification Creek, Elkhead Creek.
64	Gypsum	Gypsum and Brush Creeks.
65	Harsha	Blue River.
66	Hayden Mesa	Williams Fork, Yampa River.
67	Kannah Creek	Kannah Creek.
68	North Delta	North Fork, Gunnison River.
69	O'Neal Park	Piedra River.
70	Parachute	Parachute Creek.
71	Pine Creek	Pine Creek, Blue Creek.
72	Straight Creek	Blue River.
73	Toponas	Yampa River, Egeria Creek, Rock Creek.
74	West Paradox	West Paradox Creek.
75	Mount Sopris	Roaring Fork tributary.
76	Escalante	Escalante River.
77	Henrys Fork	Henrys Fork and Sheep Creek tributary.
78	Pack Creek	Pack Creek and Mill.
79	Green River Development Co.	Green River.
80	Ruth	Boulder Creek.
81	Gordon Creek Reservoir	Gordon Creek.
82	Carter Canal extension	Carter Creek.
83	Green Lake Reservoir	Green Lake.
84	Hickerson Park Dam	Sheep Creek.
85	Jessen Lake Reservoir	Do.
86	Long Park Reservoir	Do.
87	Spirit Lake Reservoir	Do.
88	Elwood Carter Canal	
89	Monarch Reservoir	Dry Gulch Creek.
90	Moon Lake project, 5 lakes	Yellowstone River.

[1] Corresponding to number on map.

COLORADO RIVER BASIN—Continued

[Map p. 32]

No.[1]	Name of potential project	River
91	Moraine Reservoir	Lake Fork River.
92	Red Creek Dam	Do.
93	Spider Reservoir	Do.
94	Uintah Basin Canal	Pleasant Valley.
95	Duck Fork Reservoir	Ferron Creek.
96	Grassy Lake Reservoir	Littles Creek.
97	Little Brush Reservoir	Muddy River.
98	Mill Site Reservoir	Ferron Creek.
99	Millers Flat Dam	Do.
100	Old Emery Reservoir	Muddy River.
101	Spinners Reservoir	Do.
102	Barker Reservoir enlargement	North Creek.
103	Christensen Ranch pipeline	
104	Escalante Pine Creek Reservoir	Do.
105	Long Willow Bottom Reservoir	Do.
106	Round Willow Bottom Reservoir	
107	Roundy Reservoir	Do.
108	Upper Griffin Draw Reservoir	Panguitch Creek.
109	West Panguitch Dam	Flood Wash.
110	Valley City Reservoir	Dry Wash.
111	Dry Wash Reservoir	Vega Creek.
112	Keller Reservoir	North Creek, Spring Creek.
113	Vega Reservoir	
114	Blanchett Park Reservoir	
115	Ouray Valley Reservoir	
116	Bullock Draw Reservoir	
117	Cliff Lake Reservoir	
118	Little Valley Reservoir	
119	Pearl Lake Reservoir	
120	Twin Lakes Reservoir	
121	Whiterocks Lake Reservoir	
122	Aldrich Dam	Fremont River.
123	Mill Meadows Dam	Road Creek.
124	Road Creek Reservoir	Birch Creek.
125	Teasdale Reservoir	
126	Torrey pipeline	Tributary of Middle Fork, Escalante.
127	Beaver Dam Reservoir	East Creek.
128	Extension and enlargement of Head Ferrier ditch	Needle Reservoir.
129	Needle Reservoir	Lee Creek.
130	Lee Creek ditch No. 2	West Fork, Naturita Creek.
131	Lily Land Reservoir	Horsefly Creek.
132	Paxton ditch	Cottonwood River.
133	Longpark ditch	Buttermilk Creek.
134	Adobe ditch	Lake Fork, Gunnison River.
135	Craig ditch enlargement	Do.
136	E. P. Wilson No. 3 ditch	Los Pinos Creek.
137	McDonough No. 2 ditch	Tributary of San Miguel River.
138	Alexander ditch	Kannah River.
139	Juniata Reservoir enlargement	Gunnison River.
140	O'Fallon ditch	Little Blue River.
141	Hazel ditch extension	Coal Creek.
142	Spann-Netlick ditch	Highpark Creek.
143	Highpark Lake enlargement	Razor Creek.
144	Vauga Reservoir	

[1] Corresponding to number on map.

COLORADO RIVER BASIN—Continued

[Map p. 32]

No.[1]	Name of potential project	River
145	Elkhorn Stomp ditch	Deep Creek.
146	Marie Scott Reservoir	Dallas Creek.
147	Lawhead Gulch Reservoir	Lawhead Gulch.
148	Eilbrecht—Millcreek ditch	Mill Creek.
149	Hot Springs Reservoir	Hot Springs Creek.
150	Beaver Reservoir	Mennis Creek.
151	Divide Creek highline feeder ditch	West Divide Creek.
152	Brown Reservoir	Cottonwood Creek.
153	Rich Krausen highwater ditch enlargement	Do.
154	Third enlargement Mount Sopris ditch	West Sopris Creek.
155	Reid Reservoir No. 3 enlargement No. 1	Tributary of Egeria Creek.
156	Highwater ditch	Egeria Creek.
157	Hudler Reservoir	Trail Creek.
158	Hudler enlargement and extension of Redtop Valley ditch.	Colorado River, North Fork.
159	Grimes-Brook feeder ditch No. 2	Elk Creek.
160	Extension and enlargement of relocated H.M.S. ditch	Sweetwater Creek.
161	School Reservoir	Corral Creek.
162	McDonald ditch first enlargement	Little Cottonwood.
163	Allen Basin Reservoir	Pump Creek.
164	Sunbeam ditch	Yampa River.
165	Barbour Southside	Marvine Creek.
166	Calvat ditch	White River.
167	Hill Creek No. 3 ditch	Hill Creek.
168	Sandelin ditch	Big Creek.
169	YZ enlargement and extension of D.D. Ferguson No. 2 ditch.	Mill Creek.
170	YZ enlargement of D. D. & E. Reservoir	Tributary of Bear Creek.
171	Second enlargement and extension of Martin Creek ditch.	Do.
172	Wheeler ditch	South Fork, Michigan River.
173	Phillips ditch	Short Creek.
174	The Burnt Mesa supply ditch	Hunt Creek.
175	Bar. Bel Mesa ditch supply	Tributary of South Fork, Michigan River.
176	Carbon Lake ditch	Tributary of Mineral Creek.
177	St. John ditch	East Fork of Animas Creek.
178	Blue River Irrigation Co	Blue River.
179	Orchard City irrigation district	
180	Woody Creek	Woody Creek, Roaring Fork.
181	Minnie Maud Reservoir	Minnie Maud Creek.
182	Willow Creek Reservoir	Willow Creek.
183	Daggett Lake Reservoir	Sheep Creek.
184	Sead Valley Reservoir	Sead Valley Creek.
185	Grass Lake Reservoir	East Fork Boulder.
186	Beaver Creek Reservoir	Beaver Creek.
187	Bull Dog Canyon	Bull Dog Canyon Reservoir.
188	Joe Redd Reservoir	West Coyote Creek.
189	Dixie	Virgin and Santa Clara Rivers.
190	Holbrook	Little Colorado River.
191	Winslow	Do.
192	Gillespie Dam to McDowell Dam site channel improvements.	Gila and Salt Rivers.
193	Camelsback Reservoir site to Salt River channel improvement.	Gila River.
194	Buttes Dam and Reservoir	Do.

[1] Corresponding to number on map.

COLORADO RIVER BASIN—Continued

[Map p. 32]

No.[1]	Name of potential project	River
195	Alamo Dam	Bill Williams River.
196	Moapa Valley pumping	Muddy and Colorado Rivers.
197	Panaca Valley	Meadow Valley Wash, Muddy River Basin.
198	Fort Mohave	Colorado River.
199	Central Arizona	Lower Colorado River system.
200	Pilot Knob Mesa, All-American Canal system	Colorado River.
201	West Mesa, All-American Canal system	Do.
202	Gila River Basin Reserve	San Francisco River.

GREAT BASIN

[Map p. 33]

1	Weber Basin	Weber River and tributaries.
2	Central Utah (initial)	Green, Duchesne, and Jordan Rivers.
3	Washoe (initial)	Truckee and Carson Rivers.
4	Bear River	Bear River and tributaries
5	Gooseberry	Gooseberry Creek.
6	Walker River	Walker River.
7	Washoe (ultimate), Newlands extension division	Truckee and Carson Rivers.
8	Hope Valley division	Carson River.
9	Woodruff-Cokeville	Bear River.
10	Pyramid Lake	Truckee River.
11	Walker	Walker River.
12	Fallon	
13	Skull Valley	
14	Bear River extension	Bear River.
15	Hardware	Blacksmith Fork.
16	Reese River (GW)	Humboldt River.
17	Crescent Valley (GW)	Do.
18	Buena Vista Valley (GW)	Do.
19	Paradise Valley (GW)	Do.
20	Paradise Valley (SW)	Do.
21	Middle Humboldt River (GW)	Do.
22	Upper Humboldt River (SW)	Do.
23	Quinn River Valley (GW, SW)	
24	Kings River Valley (GW)	
25	White River (GW, SW)	
26	Railroad Valley (GW)	
27	Ruby-Clover Valleys (GW, SW)	
28	Big Smoky Valley (GW, SW)	
29	Fish Lake Valley (GW, SW)	
30	Diamond and Newark Valleys (GW)	
31	Steptoe and Spring Valleys (GW, SW)	
32	Snake Valley (GW, SW)	
33	Columbia River drainage in Great Basin (GW, SW)	
34	Mason Valley (GW)	
35	Walker River	
36	Armagosa Valley (GW, SW)	
37	Daniels Dam	Little Malad River.
38	Devil Creek	Devil Creek.
39	Cleveland	Cottonwood Creek.
40	Railroad Hollow	Cut River.

[1] Corresponding to number on map.

NOTE.—GW=Ground water; SW=Surface water.

GREAT BASIN—Continued

[Map p. 33]

No.[1]	Name of potential project	River
41	Geneva	Thomas Fork.
42	Twin Lakes	Mink Creek.
43	Clifton	Clifton Creek.
44	Spring Creek	Spring Creek.
45	Condie	Cut River.
46	Sulphur Creek	Sulphur Creek.
47	Ashley	Smith's Fork.
48	Upper Bear	Bear River.
49	Rock Ford Dam repair	Beaver River.
50	Harper Canal lining	
51	South Junction Dam	
52	West Grouse Creek Dam	West Fork, Grouse Creek.
53	Benson irrigation pipeline	
54	Porcupine Dam	South Fork, Little Bear River.
55	Layton Reservoir	Kays Creek.
56	Cedar North Fields lining	
57	Deep Lake Reservoir	Spring Creek, LaVerkin Creek.
58	Meadow Hollow Reservoir	Do.
59	Newcastle Reservoir	Pinto Creek.
60	Summit Irrigation Stock Co. lining	
61	Levan lining	
62	Nephi wells	
63	River Bed wells	
64	DMAD Dam	
65	Fool Creek wells	
66	Golden Harvester well	
67	Lyndyl well	
68	Meadow lining	
69	North Fields lining and well	
70	North McCornick well	
71	Scipio well	
72	Sinks well and pond	
73	Walker Creek well	
74	Lower Lost Creek Reservoir	
75	Swans Grove Reservoir	
76	Beaver Creek Reservoir	Beaver Creek.
77	City Creek Reservoir	City Creek.
78	Paint Reservoir	Otter Creek.
79	Big Creek Reservoir	Big Creek.
80	Cottonwood Creek Reservoir	Cottonwood Creek.
81	Laketown Canal lining	
82	Laketown Canyon Reservoir	Laketown Creek.
83	Otter Creek Reservoir	North Fork.
84	Sage Creek Reservoir	Sage Creek.
85	Provo Reservoir water users' wells	
86	North Dry Creek tank and pipelines	
87	Beaver Dam Reservoir	Seely Creek.
88	Birch Creek well	Birch Creek.
89	Blue Meadow Reservoir	
90	Fountain Green lining	
91	Gunnison City Canal	
92	Jet Fox	Coal Fork Creek.
93	Mayfield lining	
94	Moroni lining	

[1] Corresponding to number on map

GREAT BASIN—Continued

[Map p. 33]

No.[1]	Name of potential project	River
95	New Canyon Reservoir	
96	Twin Creek Reservoir	
97	Bull Pasture Reservoir	Salina Creek.
98	Hatchtown Reservoir (Garfield County)	Sevier River.
99	Kings Meadow pipeline (Dastrup)	
100	Yogo Niotche Reservoir	Salina Creek.
101	Beaver Creek Reservoir	Beaver Creek.
102	Chalk Creek Reservoir	Chalk Creek.
103	Waldon Lambert Reservoir	City Creek.
104	Yellow Pine Reservoir	Beaver Creek.
105	Middle Canyon pipeline	
106	Vernon Dam	Vernon Creek.
107	Vernon lining	
108	Alta Ditch Co. pipeline	
109	Current Creek wells	
110	Lake Bottom Canal lining	
111	Lehi wells	
112	North Union Canal lining	
113	Pleasant Grove wells	
114	Salem Pond Canal lining	
115	Santaquin Reservoir	Summit Creek.
116	West Union Canal lining	
117	Daniel Canal and siphon	Strawberry River.
118	Extension Canal lining	
119	Jones Reservoir	Lake Creek.
120	Lake Creek Canal lining	
121	East Willow Springs pressure irrigation system	
122	Four Mile Reservoir	Weber River.
123	North Bench pipeline	
124	Rice Creek pipeline	
125	South Davis County Water Improvement District	
126	Bountiful Water Subconservancy District	
127	Centerville-Deuel Creek Irrigation Co	
128	Weber-Box Elder Conservation District	
129	Haight's Creek Irrigation Co	
130	Reese River (GW)	Humboldt River.
131	Crescent Valley (GW)	Do.
132	Buena Vista (GW)	Do.
133	Paradise Valley (GW)	Do.
134	Paradise Valley (SW)	Do.
135	Middle Humboldt (GW)	Do.
136	Upper Humboldt (SW)	Do.
137	Quinn River Valley (GW, SW)	
138	Kings River (GW)	
139	White River (GW, SW)	
140	Railroad Valley (GW)	
141	Ruby-Clover (GW, SW)	
142	Big Smoky (GW, SW)	
143	Fish Lake (GW)	
144	Diamond-Newark (GW)	
145	Steptoe-Spring (GW, SW)	
146	Snake Valley (GW, SW)	
147	Columbia River drainage in Great Basin (GW, SW)	
148	Amargosa	

[1] Corresponding to number on map.

GREAT BASIN—Continued

[Map p. 33]

No.[1]	Name of potential project	River
149	Sand Ridge	Little Malad River.
150	McGerry Park Reservoir	North Fork, North Creek.
151	Milk Ranch Reservoir	Indian Creek.
152	Basin Creek Reservoir	Basin Creek.
153	Farmington Creek Reservoir	Farmington Creek.
154	Pine Hollow Reservoir	Little Creek.
155	Little Creek Reservoir	
156	Pole Canyon Reservoir	
157	Eagle Hollow Reservoir	Pioneer Creek.
158	Lost Creek Reservoir	
159	Hul Canyon Reservoir	
160	Sheep Creek Reservoir	
161	Argenta Reservoir	
162	Blue Lakes Reservoir	Twelve Mile Creek.
163	Coop Creek Reservoir	
164	Heiner Creek Reservoir	Heiner Creek.
165	Bench Creek Reservoir	Bench Creek.
166	Hobble Creek Reservoir	Little Hobble Creek.
	Miscellaneous areas in Nevada (not mapped, but included in statistics).	
167	Harney	Silvies River.

PACIFIC NORTHWEST BASIN

[Map p. 34]

1	Snake Narrows	Snake River.
2	Swan Valley	Do.
3	Burns Creek Dam, Reservoir, and powerplant	Do.
5	Teton Basin	Teton River and ground water.
6	Roberts Moreland	Ground water.
8	Fort Hall extension	Bannock Creek and ground water.
9	Lake channel	Snake River.
10	Dietrich area	Ground water.
11	Salmon Falls	Snake River, Rock Creek, and ground water.
12	Big Lost River	Ground water.
13	Lower Rock Creek division	Rock Creek.
14	Guffey, Long Tom, and Hillcrest units, Snake River project.	Boise River and ground water.
15	Gold Fork, Long, and Round Valley units, Snake River project.	Gold Fork and North Fork, Payette River.
16	Garden Valley and Scriver Creek units, Snake River project.	Payette River.
17	Montour north and south units, Snake River project	Do.
18	Willow Creek unit, Snake River project	Do.
19	Initial Butte unit, Snake River project	Do.
20	Payette Heights unit, Payette division, Boise project	Do.
21	Council	Lost Creek.
22	Main Weiser and Little Weiser	Weiser and Little Weiser.
23	Mann Creek	Mann Creek.
24	Minor pumping division, Snake River project	Snake River.
25	Wickahoney division, Bruneau project	Do.

[1] Corresponding to number on map.

PACIFIC NORTHWEST BASIN—Continued

[Map p. 34]

No.[1]	Name of potential project	River
27	Duncan Ferry Dam and Reservoir, upper Owyhee project.	Owyhee River.
28	Bully Creek extension, Vale project	Bully Creek and Malheur River.
29	South Fork division, Burnt River project	South Fork, Burnt River.
30	Upper division, Baker project	Powder River.
31	Challis Creek unit, Challis project	
32	Jackson Hole irrigation project	Snake River.
33	Granite Creek	Hoback River.
34	Elbow Dam and Reservoir	Greys River.
35	Upper Star Valley	Crow Creek.
36	Ririe project	Willow Creek.
38	Rockland	Rock Creek.
39	Raft River	Snake River.
40	Almo	Raft River.
41	Oakley Fan	Snake River.
43	Jerome-Wendell-Gooding area	Ground water.
44	Medicine Lodge	Medicine Lodge Creek.
45	Birch Creek	Birch Creek.
46	Arco division, Big Lost River project	Antelope Creek.
47	Bruneau division, Bruneau project	Snake River.
48	Bennett Creek	Bennett Creek.
49	Hornet Creek	Hornet Creek.
50	Northside unit, Garden Valley division, Snake River project.	Payette River.
51	Castle Creek	Castle Creek.
52	Sucker Creek	Sucker Creek.
53	Jordan Valley Dam and Reservoir, upper Owyhee project.	Jordan Creek.
54	Jacobsen Gulch	Snake River.
55	North Fork division, Burnt River project	North Fork, Burnt River.
56	Dark Canyon division, Burnt River project	Burnt River.
57	Baker project	Wolf Creek.
58	Grande Ronde	Grande Ronde River, Catherine Creek.
59	Pahsimeroi	Goldberg Creek.
60	Agency	Agency Creek.
61	Hayden	Bear Creek.
62	Leadore	Hawley Creek.
63	Lemhi Valley	Texas Creek.
64	Lower Lemhi	Salmon River.
65	Yearian	Yearian Creek.
66	Squirrel Meadows	Squirrel Creek.
67	Alta	Teton Creek.
68	St. Anthony-American Falls, West Side area	Ground water.
69	Cassia Creek	Cassia Creek.
70	Big Wood River	Ground water.
71	Alpine irrigation project	Snake River.
72	St. Anthony-American Falls, West Side area	Ground water.
73	Mud Lake	Do.
74	Little Lost River	Little Lost River and ground water.
75	Sinker Creek	Sinker Creek.
76	Blue Gulch	Bruneau River.
77	Manson unit, Chelan division, Chief Joseph Dam project.	Chelan River.

[1] Corresponding to number on map.

PACIFIC NORTHWEST BASIN—Continued

[Map p. 34]

No.[1]	Name of potential project	River
78	East unit, Greater Wenatchee division, Chief Joseph Dam project	Columbia River.
79	Howard Flat unit, Greater Wenatchee division, Chief Joseph Dam project	Do.
80	Brays Landing unit, Greater Wenatchee division, Chief Joseph Dam project	Do.
81	Methow division, Chief Joseph Dam project	Do.
82	Oroville-Tonasket unit, Okanogan-Similkameen division, Chief Joseph Dam project	Do.
82-A	Whitestone-Coulee unit, Okanogan-Similkameen division, Chief Joseph Dam project	Okanogan River.
83	Columbia Basin	Columbia River.
84	Colville River Basin	Colville River.
85	Upper Horse Heaven	Klickitat River.
86	Sandpoint project, Pend Oreille River Basin	Pend Oreille River.
87	Eureka Flats	Snake River.
88	Spokane Valley	Spokane River.
89	Touchet River division, Walla Walla project	Walla Walla River.
90	Marcus Whitman	Do.
91	Milton-Freewater	Columbia River.
92	Kennewick division extension, Yakima project	Yakima River.
93	Supplemental storage, Yakima project	Do.
94	Ahtanum division, Yakima project	Do.
95	Upper division, Baker project	Powder River.
96	Birch Creek diversion unit, Umatilla project	Umatilla River.
97	Kootenai River Basin, North Bench	Moyie River.
98	East Greenacres unit, Rathdrum Prairie project	Spokane River.
99	Kalispell	Flathead River.
100	Plains	Clark Fork.
101	Prairie division, Rathdrum Prairie project	Spokane River.
102	Bluebottle Flat unit, Foster Creek division, Chief Joseph Dam project.	Columbia River.
103	Bridgeport Bar unit, Foster Creek division, Chief Joseph Dam project.	Do.
104	Greater Wenatchee division, Chief Joseph Dam project Antoine Creek unit. North Pateros unit. South Pateros unit. Moses Coulee unit.	Do.
105	Okanogan-Similkameen division, Chief Joseph Dam project.	Okanogan River.
106	Alameda unit, Shoreline pumping division, Chief Joseph Dam project.	Columbia River.
107	Condon Ferry, Shoreline pumping division, Chief Joseph Dam project.	Do.
108	Goose Lake, Shoreline pumping division, Chief Joseph Dam project.	Do.
109	Middile division, lower Horse Heaven project	Do.
109	Upper division, lower Horse Heaven project	Do.
110	Little Spokane Valley	Spokane River.
111	John Day	Columbia River.
112	St. Andrews-Sagebrush Flats division, Chief Joseph Dam project.	Do.
113	Other divisions, Chief Joseph Dam project (not mapped)	Do.
115	FDR Lakeshore	Do.
116	Plymouth division, McNary project	Do.

[1] Corresponding to number on map.

PACIFIC NORTHWEST BASIN—Continued

[Map p. 34]

No.[1]	Name of potential project	River
117	Hall Creek	Hall Creek.
118	Kettle River	Kettle River.
119	Other land	Pend Oreille River.
120	Lower Snake River	Snake River.
121	Icicle Irrigation District	Wenatchee River.
122	Upper John Day	John Day River.
123	Arlington project, main stem, Columbia	Columbia River.
124	Cold Springs	Do.
125	River Basin	Clark Fork.
126	Paradise division, Pendleton project	Umatilla River.
127	South Reservation division, Pendleton	Do.
128	Stanfield extension division, Pendleton project	Do.
129	Prairie division, Rathdrum Prairie project	Spokane River.
130	Deer Lodge Valley	Clark Fork.
131	Camas Prairie	Flathead River.
132	Mosier	Columbia River.
133	The Dalles project, western division	Do.
134	Crooked River project extension	Crooked River.
135	Paulina	Do.
136	Squaw Creek	Deschutes River.
137	Applegate division, Rogue River Basin project	Rogue River.
138	Evans Valley division, Rogue River Basin project	Do.
139	Illinois Valley division, Rogue River Basin project	Do.
140	Merlin division, Rogue River Basin project	Do.
141	Agate Dam and Reservoir, Rogue River Basin project	Do.
142	Umpqua Basin	Umpqua River.
143	Hopewell project and private storage	Willamette River.
144	Monmouth-Dallas	Do.
145	Red Prairie	Yamhill River.
146	Tualatin	Tualatin River.
147	Chehalis River	Chehalis River.
148	Cowlitz River Basin	Cowlitz River.
149	Clark County Benches	Columbia River.
150	Glenwood	Klickitat River.
151	Chambers Prairie	Nisqually River.
152	Green Puyallup	Green Puyallup River.
153	The Dalles project, eastern division	Columbia River.
154	Deschutes project, supplemental storage	Deschutes River.
155	Post	Crooked River.
156	Wapinitia	White River.
157	Medford division, Rogue River Basin project	Rogue River.
158	Grave Creek division, Rogue River Basin project	Do.
159	Albany	South Santiam River.
160	Brownsville	Calapooya River.
161	Calapooya	Do.
162	Canby	Molalla River.
163	Clackamas	Clackamas River.
164	Coburg	McKenzie River.
165	Cottage Grove	Willamette River.
166	East Long Tom	Do.
167	Eugene	Do.
168	Independence	Luckiamute River.
169	Marys River	Marys River.
170	Molalla	Molalla River.
171	Pleasant Hill	Willamette River.

[1] Corresponding to number on map

PACIFIC NORTHWEST BASIN—Continued

[Map p. 34]

No.[1]	Name of potential project	River
172	Salem	North Santiam River.
173	Scio	South Santiam River.
174	Springfield	Willamette River.
175	Stayton	North Santiam River.
176	West Long Tom	Long Tom River.
177	Yamhill	Yamhill River.
178	Chehalem	Willamette River.
179	Marysville-Arlington	Stillaguamish River.
180	Nooksack	Nooksack River.
181	Sequim	Dungeness River.
182	Yelm	Nisqually River.
183	Little Blackfoot-Cottonwood project, transbasin diversion.	
184	German Gulch Dam and Canal	Upper Clark Fork.
185	Browns Gulch	Do.
186	Woodside Canal	Bitterroot River.
187	Big Creek Lakes	Do.
188	Blodget Creek Dam	Do.
189	Bear Creek Dam	Do.
190	Burnt Fork	Do.
191	Willow Creek	Do.
192	Kleinschmidt Flat	Blackfoot River.
193	St. Regis Diversion	Clark Fork.
194	Lake Mary Ronan	Flathead River.
195	Sunny Slope pumping	Do.
196	Kootenai River Basin (Montana-Idaho)	
197	Walla Walla River Basin	Walla Walla River.
198	Umatilla River Basin	Umatilla River.
199	Powder River Basin	Powder River.
200	Yakima River Basin	Yakima River.
201	Columbia River Basin	Columbia River.
202	Palouse River Basin	Palouse River.
203	Spokane River Basin	Spokane River.
204	John Day River Basin	John Day River.
205	Umpqua Basin	Umpqua tributaries.
206	Malheur River Pasin	Malheur tributaries.
207	Owyhee Basin	Owyhee tributaries.
208	Deschutes River Basin	Deschutes tributaries.
209	Rogue River Basin	Rogue River tributaries.
210	Coastal area	
211	Cowlitz River Basin	
212	Puget Sound	

[1] Corresponding to number on map.

CENTRAL PACIFIC BASIN

[Map p. 35]

No.[1]	Name of potential project	River
1	Swan Lake, Yonna Valley	Klamath Lake.
2	Klamath project extensions	Klamath and Lost Rivers.
3	Lost River storage unit	Lost River.
4	Butte division, Klamath project	Klamath River.
5	Shasta Valley project	Shasta River.
6	Trinity River division, Central Valley project	Trinity, Sacramento Rivers.
7	Black Butte unit (Corps of Engineers reservoir)	Stony Creek.
8	Round Valley unit, north coast project	Eel River.
9	Yuba River, Central Valley project	Yuba River.
10	Yolo Zamora unit, Central Valley project	Sacramento River.
11	American River, Central Valley project	American River.
12	Cosumnes River, Central Valley project	Cosumnes River.
13	New Hogan (Corps of Engineers reservoir)	Calaveras River.
14	San Felipe division	Sacramento River.
15	East Side division, Central Valley project	Sacramento, San Joaquin River and tributaries.
16	Buchanan Reservoir (Corps of Engineers reservoir)	Chowchilla River.
17	Hidden Reservoir (Corps of Engineers reservoir)	Fresno River.
18	Terminous Reservoir (Corps of Engineers reservoir)	Kaweah River.
19	Success Reservoir (Corps of Engineers reservoir)	Tule River.
20	Yuba River additions, Central Valley project	Yuba River.
21	Rollins, Central Valley project	Bear River.
22	Garden Bar, Central Valley project	Do.
23	American River additions, Central Valley project	American River.
24	American-Cosumnes unit, Central Valley project	American and Cosumnes Rivers.
25	East Side ultimate	San Joaquin River.
26	Big Valley Irrigation District	Pitt River.
27	Browns Valley	French Dry Creek, Yuba River tributary.
28	South Sutter	Bear River.
29	Nevada Irrigation District	Do.
30	Middletown County Water District	Dry Creek tributary to Putah Creek.
31	Georgetown	Pilot Creek tributary to American River.
32	Jackson Valley Irrigation District	Jackson Creek tributary to Cosumnes River.
33	South San Joaquin	Stanislaus River.
34	Pleasanton Township Consumers Water District and Alameda County Water District.	Arroyo Del Valle, tributary to Alameda Creek.
35	Santa Clara Valley Water Conservation District	Coyote Creek.
36	San Benito	San Benito River.
37	Alpaugh Irrigation District	

SOUTH PACIFIC BASIN

[Map p. 35]

1	Santa Ynez River Water Conservation District	Santa Ynez River.
2	Pleasant Valley project	Santa Clara River.
3	Goleta County Water District	Santa Ynez River.
4	Calleguas project	Sespe Creek tributary of Santa Clara River.
5	Santa Margarita project	Santa Margarita River.
6	Bonsall Dam	San Luis Rey River.
7	Palo Verde Mesa	Colorado River.

[1] Corresponding to number on map.

LOWER ARKANSAS-RED-WHITE RIVERS BASIN

[Map p. 30]

No.[1]	Name of potential project	River
1	Sandy Creek Reservoir	Blue River.
2	Tupelo Reservoir	Clear Boggy Creek.
3	Hugo	Kiamichi River.
4	Broken Bow Reservoir	Mountain Fork.
5	Pine Creek Reservoir	Little River.
6	Lukfata Reservoir	Glover Creek.
7	Boswell Reservoir	Boggy Creek.
8	Liberty Bottoms	Red River.
9	Goodland	Do.
10	Other	Do.
11	Atoka	Boggy Creek.
12	Chickasaw	Chickasaw Creek.
13	McGee	McGee Creek.
14	Buck Creek	Buck Creek.
15	Keystone Reservoir	Arkansas River.
16	Fort Gibson	Do.
17	Webbers Falls	Do.
18	Porum	Canadian River.
19	Chewey	Illinois River.
20	Sardis Reservoir	North Jack Fork Creek.

LOWER MISSOURI RIVER BASIN (KANSAS ONLY)

[Map p. 28]

1	Quenemo unit	Marais des Cygnes.
2	Greeley unit	Pottawatomie Creek.
3	Paola unit	Big Bull Creek.
4	Ground water pumping	Marais des Cygnes.

[1] Corresponding to number on map.

END

DATE

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4-29-74

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